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F. F. M. BROWNE, *M.D.*

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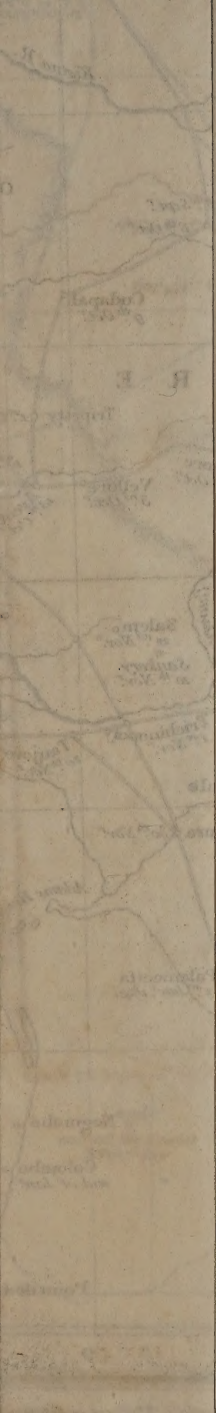

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AN ESSAY

ON

THE EPIDEMIC CHOLERA

OF INDIA.

BY

REGINALD ORTON,

SURGEON H. P. LATE OF HIS MAJESTY'S THIRTY-FOURTH REGIMENT OF FOOT.

Recte ponitur, *vere scire, esse per causas scire.*

LORD BACON.

SECOND EDITION, WITH A SUPPLEMENT.

LONDON:

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1831.

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TO

SIR J. M'GRIGOR, BART. M.D. F.R.S.

Director General of the Army Medical Department.

SIR;

The distance at which I am situated renders it impossible for me to obtain the honour of being permitted to prefix your name to this Essay, without such a delay to its publication as would probably render it of comparatively little interest and utility. But the industry which has been bestowed upon it is such as to claim some portion of your approbation; its subject, however inadequately treated, is highly worthy of your attention; and I am ambitious enough to hope, that the inferences it contains may be weighed by those most capable of perceiving their truth or fallacy: hence I am induced and emboldened to inscribe it to you; and I beg you will accept this mark of my profound respect for your equally distinguished talents and situation.

I have the honour to be, Sir,
your most obedient,
humble servant,
REGINALD ORTON.

Madras, February, 1820.

PREFACE.

CHOLERA is well known as a disease of tropical climates and warm seasons, but, as far as our information extends, it has rarely prevailed to any great degree in this country, until the autumn of the year 1817; when it appeared in Bengal, in the form of a very peculiar and malignant epidemic, which has since extended its ravages, apparently over the whole of the immense territories under the authority and influence of the British in India.

This disease has swept off a very considerable proportion of the population of India, for in its higher degrees it is one of the most dangerous maladies to which the human frame is subject. At the same time, it presents to our observation a train of morbid phenomena, which appears to be unexampled in the annals of medicine; whether we consider their number and variety, their striking and peculiar nature, or the im-

portant pathological inferences to which they may lead. And the interest with which these considerations are calculated to inspire us is, if possible, enhanced by the novelty attending this violent form and wide prevalence of cholera, and the obscurity in which its causes and pathology are involved. It has therefore appeared to me to be in some measure incumbent on every member of the profession, who has an opportunity of observing this epidemic, to add his mite to the scanty stock of general information concerning it.

Actuated by these sentiments, I presented to the Medical Board of this Presidency a collection of "Remarks on Cholera," the result of my earliest experience in the disease. They were pleased to honour that hurried and inconsiderate production with their thanks and approbation; hence I was led on to further exertions, and more extensive experience and research have furnished me with a mass of facts and reasoning on the subject, such as, I trust, is not altogether unworthy to meet the public eye.

Many other circumstances have concurred to induce me to attempt a task of no small extent and difficulty,—that of *presenting a correct picture of the disease; explaining, if possible, its nature and causes; and describing the various modes of treatment which have been adopted, with their consequences.* The undertaking long ap-

peared to be completely declined by all whose opinions might, *ab officio*, lay claim to greater deference than my own. The pathology and causes of the disease are very little known; as the direct confessions of many, and the silence of more, fully prove. A collection of facts and observations regarding it, if accurately recorded, must be valuable; and, lastly, the speculations which are founded on them, even though unsuccessful, may not be useless; for the hints which they will probably afford, and the inquiries into their truth or fallacy which they will give rise to, must all tend to the extension of our knowledge of the important questions which they embrace.

It is not, however, without all the diffidence which becomes me, that I offer to the Public, views so extensive as will be found in the following pages. I am aware that I have ventured far in the dangerous tracks of theory, but I trust it will be evident that I have had experience for my guide: and whatever may be my errors, I will hope that the principles which I have endeavoured to establish will be deemed of sufficient importance to be fully examined, and either confirmed, modified, or refuted. Should they be found to be true, they will bring us intimately acquainted with the rational and principal cause of a disease which endangers the lives of sixty millions of human beings.

If I have been led by the excitement of the subject to too hasty generalization and false inference, an indulgent Public will forgive where they cannot approve.

The Edinburgh Reviewers observe: "we have no Baconian horror at hypotheses of any sort; but, on the contrary, we are heretical enough to believe, that when they are not substituted for facts they rather do good than harm; that they stir up inquiry and make inquirers, when perhaps there would have been neither the one nor the other;—that when true they stand, and when false they are refuted." This temper in the Reader is all I ask, with regard to the speculative views which are here submitted to his investigation; and I trust his candour and attention will be repaid, in so far at least, that he will find these opinions assuming so distinct and tangible a form, that they may be readily applied to the touchstones of superior knowledge, observation, or experiment.

Scepticism, and the knowledge and confession of our ignorance, are, doubtless, valuable means of avoiding error; but this advantage is merely negative; and it can scarcely be doubted that even a false belief on any unexplained subject, if it is not so implicit as to lead to erroneous action, or to exclude opposing evidence, yet is sufficient to excite further inquiry, is preferable to that supineness which obstinate scepti-

cism and professed ignorance almost necessarily produce; for false hypotheses have frequently led to the discovery of truth. It has been a common observation in this country, that the great cause of the epidemic cholera is perfectly inscrutable—that it never will be discovered: and this is one of those opinions which strongly tend to verify themselves; for whoever entertains it, will not only decline all inquiry as hopeless, himself, but will either wholly neglect the researches of others, or sit down to the examination of them with a prejudice against them, which the strongest facts or the clearest reasoning shall be unable to remove. The *suppositio impossibilis* has always been one of the principal obstacles to discovery and improvement.

I will detain the reader with but one more apology for the theoretical discussions which I have indulged in. The symptoms of this disease have long appeared to me to require only being accurately and fully recorded, to furnish most important indications and data for general physiological and pathological researches; and the natural phenomena which have attended its prevalence have been so remarkable, and apparently so uniform, as to promise to throw a light on the long-sought Causes of Epidemical Diseases. Anxious, therefore, to bring these important particulars to general

notice, I would have confined myself to the bare observation and collection of facts, and have left the task of drawing and supporting the inferences to which they lead, to minds more capable of it: but it is impossible entirely to separate the theoretical from the practical part of medicine. Observation appears incapable of being perfectly awakened without the fascinations of theory; the mind requires a clue to assist its inquiries, and admits with apathy and with difficulty ideas which it is incapable of arranging. On the other hand it may be urged, that observation excited by theory, tends to illusion, and the perversion of experience; but this is a fault which it is more within our power to avoid; and, aware that the value of my labours will be in proportion to the truth, and not to the probability or consistency, of their general results, my first attention has been directed to laying a foundation of incontrovertible FACTS;—the superstructure of theory which I have raised on it, if found faulty, may be thrown down, and a perfect one erected in its stead.

On occasions of this kind, it is usually of little avail to deprecate the severity of criticism; but I have uncommon reasons to hope for, as well as to need indulgence. Entirely unaccustomed to literary composition, I have only been persuaded to undertake it by a

conviction that circumstances had thrown in my way information that deserved to be made public. A vertical sun opposes a physical obstacle to intellectual exertions, which the critic, seated calmly at his desk under a happier sky, can form little idea of. The means of reference to professional works, in this distant and half-civilized country, must necessarily be very limited, under any circumstances; to me they have been extremely so, for this essay has chiefly been written under all the inconveniences and literary privations attendant on continual travelling.

To the Medical Board of Madras, I have to acknowledge the most important obligations. By their exertions the medical officers of the Establishment have been furnished with much essential information regarding the disease; and to their kindness I am indebted for the invaluable privilege of inspecting their records. I am likewise deeply indebted to a volume of "Reports on the Epidemic Cholera," published by the Medical Board of Bombay; but, though I have largely taken advantage of that work, I have been able to present but a comparatively small portion of the information with which it abounds.

PREFACE

TO THE

SECOND EDITION.

This work was published eleven years ago, in a very unprepossessing form, at Madras; where not a sheet of printing paper was to be procured, and at a press which had scarcely ever been occupied but on the Chinese straw-paper sheets of a weekly journal, consisting chiefly of extracts from English newspapers; for that populous capital of a British Presidency far more extensive than the mother country, is surpassed in literary activity by some of the infant "villages" in the back-settlements of America. This may account for some of the imperfections of the work, but the principal of them must rest on my own head. It was my intention to have followed it up by another volume, containing an examination of the question of the contagious nature of the disease—of its

minor remote causes, and its habitudes—a detail of the many different methods in use of combating the disease—and a collection of cases;—all which subjects were either entirely deferred, or but slightly touched upon in that work. Loss of health, and with it of mental as well as bodily energy, and removal from India, prevented my resuming the undertaking. I found the subject possessing but a very subdued and secondary degree of interest in this country, and ceased to find it continually uppermost in my own thoughts. I therefore never had the courage to republish the work in England; but the entrance of the disease into Russia, and an offer from our Government to employ me in inquiring into its nature in that country, re-awakened in my mind all the fascinating but fearful interest which it is now so generally inspiring; and I might have been able to offer to the Public a work more worthy of its attention, had not a severe return of illness obliged me to think only of preserving existence. At the present moment, however, with this awful pestilence so closely impending, I have reason to hope that this imperfect chronicle of the disease, for the first two or three years of its existence as a wide spreading epidemic, and inquiry into its nature and causes, may not be without value, even in its present

state. Since it was written the epidemic has in innumerable instances started up afresh in India, and seems to have become naturalized to the country, as the plague is to Turkey. It has overrun almost all the rest of Asia, and has exhibited its hideous features to the scientific men of a great part of Europe. Great opportunities have therefore existed of acquiring additional information concerning it; a collection and digest of which would be highly valuable, and might be expected to be found in a diffuse work on the subject published at the present day. The circumstances above mentioned must be my excuse for not attempting that task in all its extent; but I have endeavoured in a somewhat desultory Supplement partly to supply the deficiencies of the original work, and to throw together the principal facts on the various branches of the subject which I have since been able to collect.

The original part is scarcely at all altered from the state in which it first appeared; and the reader—if he finds this inquiry lead him on so far—will find some of the inferences there drawn somewhat modified in the Supplement. Fresh, and I trust undeniable proofs will there be adduced of the general agency of a great atmospheric cause, which is evident to our senses and our instruments; but the same paramount

importance will no longer be attached to it; for the present state of our experience seems to me fully to prove the existence of another agent, to which the wide diffusion and continuance of the disease, though not its origin, are to be principally attributed.

HAUXWELL,
AUGUST, 1831.

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ON THE

EPIDEMIC CHOLERA OF INDIA.

CHAP. I.

DESCRIPTION OF CHOLERA.

SECT. I.

OF THE SEVERER FORM OF CHOLERA, OR THE COMMON FORM OF THE EPIDEMIC.

THE attack of this epidemic is usually sudden and violent, but, in a great majority of instances, not without some premonitory symptoms. It is frequently preceded by a simple diarrhœa, continuing several days, and still more commonly by other slight affections which are more characteristic of the disease. Most commonly it is in the middle of the night, or early in the morning that these ominous disturbances are first felt. An extraordinary depression of spirits and general uneasiness comes on, attended by tremor and sense of debility; giddiness and headach, and occasionally ringing in the ears, are also felt, particularly on rising from the recumbent posture, or making any sudden movement. Pains resembling those which attend the accession of fever are sometimes felt in the limbs. The bowels are griped occasionally, and natural loose stools occur; nausea comes on. The circulation and the temperature of the body are variously disturbed, but most commonly the pulse is accelerated and weakened, and the

skin is moist, and colder than usual to the hand of another. These symptoms, or some of them, not unfrequently continue many hours, or even a day or two, without proceeding much farther, or exciting much attention.

In general, however, the severer affections quickly set in. The stools become extremely frequent and watery, of a peculiar unnatural smell, and greyish white colour, so as exactly to resemble conjee or barley water in appearance; vomiting comes on, and, after the common contents of the stomach, a clear watery fluid, interspersed with flakes of mucus, is discharged; copious sweat breaks out; and the anxiety and the debility rapidly increase. The countenance assumes a very peculiar appearance, by which alone the disease may generally be distinguished. This is so remarkable as occasionally to render servants recognized with difficulty by their masters, even in the early stage of the disease*. It is difficult to be described, but it bears a striking resemblance to the appearance of *age*; and seems to arise from the paleness, wasting, and shrinking of the features, and the depressed and disturbed state of the mind, conveying into the countenance a strong expression of care, anxiety, and alarm.

It is usually during a fit of vomiting that spasms of the muscles are first felt. They are almost invariably of the tonic kind, resembling common cramps; recurring in paroxysms of the duration of a minute or two, and at intervals of a few minutes, and attended with excruciating pain. They affect, occasionally and in turns, the whole of the muscles of voluntary motion, but particularly those of the legs and feet. In general they are far from extending at once over the whole muscular system, for they very commonly attack but one extremity at a time, or even only one muscle, particularly one of the gastrocnemii, drawing up its belly until it resembles a clenched hand in hardness, and almost in shape. The abdominal muscles and those of the chest are frequently affected,

* See "Reports on the Epidemic Cholera," published by the Medical Board of Bombay. Preface.

but not particularly so. In no instance have I had occasion to believe that the spasms were injurious by interrupting respiration or circulation. Great disturbances of these functions are indeed observed to accompany them, but these effects equally follow when the extremities only are affected. The returns of the paroxysms of spasm are frequently brought on by the slightest exertion; and in particular, they appear to be intimately connected, in regard to cause, with those of vomiting; for these affections frequently recur together. Great debility of the circulating system also very generally attends the accession of the spasms or severe vomiting. I have often found the pulse sink at once, on the first appearance of spasm in the muscles, from the natural state, so as scarcely to be felt, or even disappear entirely from the wrist in an instant; and in such subjects as are not affected with spasms (for they are not a constant symptom), this fatal failure of the circulation not unfrequently appears with the first paroxysm of vomiting. The frequency of the pulse is very variable. In many instances it is rapid from the commencement; in others its frequency is little changed in the early stage; but in all it becomes extremely quick as the disease advances.

The respiration from the first severe accession is observed to be hurried and oppressed, and is frequently complained of. As the disease increases in violence, the colour of the whole surface changes to a livid hue, particularly round the eyes, and at the extremities. The surface is bathed in cold sweat; the hands and feet, and afterwards the whole body, rapidly grow cold. The plumpness and natural expression of the features disappear; they become sharpened—in short, the whole *facies Hippocratica* succeeds; and with a rapidity which is very surprising, for it is scarcely possible to conceive how so great an emaciation of the countenance can take place, as it frequently does, in an hour or two.

A small number only of the symptoms of this disease have yet been described, and it is necessary to return to the early

stage, when the spasms and other severe affections first set in. From this period an extreme thirst invariably attends, and, notwithstanding the coldness of the body, there is an ardent longing for great quantities of cold water; which, however, though gratefully and eagerly received, frequently affords no relief to the morbid sensation. An acute pain is felt in the situation of the stomach, which has been generally and distinctly observed to be increased on pressure, and sometimes on inspiration. A sense of heat is likewise felt in the same situation, and often extending over the whole abdomen, which has been compared to the imagined effect of burning embers, or a blister in the stomach. Great oppression and sense of anxiety are also referred to the præcordia. The urine sometimes appears in the early stage, and then it is pale and watery; but, under the existence of the severer symptoms, that secretion, as well as that of bile, is completely suppressed. The tongue is natural at first, but in the course of the disease it becomes furred, and deficient of moisture, and dryness of the mouth and throat is very generally complained of. The hands are sodden with cold sweats, shrivelled and wrinkled, like those of a washerwoman after a day's labour, and frequently of a very dark blue colour. A strong and disagreable odour, perfectly *sui generis*, is exhaled from the body, and forms another of the striking features of the disease, which once seen must be impressed on the memory for ever.

Although the temperature of the body is greatly diminished, the patient is not sensible of it; on the contrary he often complains of heat, and is incessantly throwing off the bed-clothes, or at least uncovering his hands and feet, even when they are quite cold. These movements are, however, more occasioned by an extreme restlessness and anxiety, which prevent his remaining a minute in the same position. In no other disease, I believe, with the exception of hydrophobia, does this symptom prevail in an equal degree, for it exceeds that which we frequently meet with before death in

many diseases, and which has obtained the expressive name of "*a mortal inquietude.*" It appears to be attended with such an extreme degree of suffering as human nature cannot long support; and accordingly we seldom find it of long duration. It is gradually relieved, or removed by stupor; and, though these symptoms are of so opposite a nature, they are frequently present in a very considerable degree at the same time; the patient feeling a constant inclination to doze, and waking every minute, tossing and groaning in a dreadful state of anxiety.

On the accession of the spasms, or, in those subjects in whom they do not appear, of the vomiting, the other symptoms above described usually either make their appearance or undergo a marked exacerbation. The disorder at that period seems to be fully developed, and the great struggle takes place. It is quickly decided. After an uncertain continuance of this severity of the symptoms, to which I cannot with truth apply a term of greater precision than *a few hours*, a remarkable change takes place, which might lead a practitioner unacquainted with the disease to congratulate himself on having arrested its progress, and to form a favourable prognosis, even when death is approaching with rapid strides. The spasms, the vomiting, and the purging cease, usually about the same time. Whatever is taken into the stomach is retained, even though in large quantity, and clysters not rejected as formerly. About this time likewise, the above-mentioned state of dozing and stupor appears, and considerably resembles natural sleep. But any favourable inferences which may be drawn from these appearances are quickly contradicted by the continued extreme weakness of the circulation, the coldness and livid colour of the surface, and the deathly expression of the countenance.

The powers of life continue rapidly to fail. The pulse becomes quite lost at the wrist, and even at the humerus; the pulsation of the heart itself is felt extremely feeble. The eye is sunk back and fixed in its socket. The cornea becomes

dull and glassy, or is covered with a transparent film, which possesses considerable tenacity, and may be removed for inspection. From the shrinking and wasting of the features, or perhaps from paralysis, the eyelids are rendered incapable of performing their office, so that in the attempts to sleep, the eye is half open; occasionally the pupil is scarcely covered. Deafness, preceded or accompanied by tinnitus aurium, is very common in this stage; false vision, blindness, and dilated pupil are equally so, and the iris is often found to have lost its sensibility to the stimulus of light. Speech becomes difficult, and the voice grows hoarse, hollow, and scarcely intelligible, or entirely lost. The breath has been observed to be cold, "as if it came out of a lump of clay." The internal senses are occasionally observed to survive the other faculties, but more commonly they are absorbed by stupor. Respiration is short and laborious, and frequently stertor supervenes.

After a farther continuance of some hours, with various degrees of the preceding symptoms, death closes the scene; usually, I believe, with little suffering; at least in the more weakly habits, for in such cases the abolition of the senses, both external and internal, indeed the whole of the animal and natural functions, appears to be complete before death; an imperfect respiration, and a very small degree of circulation only remaining, which gradually cease without an effort.

Such are the appearances which present themselves where the exertions, both of nature and art, are inadequate to the cure. If the termination is different, a favourable crisis is generally observable, which is almost invariably marked by *sleep* of unusual soundness, attended by warm perspiration, and light and natural respiration. This remarkable symptom does not appear to be chiefly owing to the opium which has been exhibited, for I have seen it occur in an equal degree in cases where little, or even no opium had been given. It happens to the patient at all hours of the day, and under all

circumstances; even in the midst of noisy and crowded wards, where exertions are making to save his less fortunate fellow-sufferers. The favourable change takes place at all periods of the disease, but most frequently before that morbid quiescence, with its attendant symptoms, which has been noticed, for this state is very generally followed by death. On waking, the patient feels himself thoroughly relieved, and expresses his satisfaction in the strongest terms. At the same time an evacuation of bilious feces and urine usually takes place; and from this period a considerable purging of black, green, or yellow feculent matter arises. At this time also, other signs of increased action manifest themselves. The pulse rises above the natural standard both in frequency and volume; the skin grows rather hot, though moist, and frequently there is copious perspiration. But, notwithstanding these disturbances, the sensations are in the highest degree comfortable; probably from the contrast with the extreme suffering from which they have been so suddenly and completely relieved.

The Bengal Medical Board have given a luminous description of this "stage of excitement or reaction," which, in a greater or less degree, appears always to follow the favourable crisis. They have observed it rising to a great height, assuming all the characters of the idiopathic bilious fevers of the country, and occasionally becoming fatal*. This, however, does not appear to have been commonly the case on the other Establishments. A slight and salutary degree of reaction only has usually followed, which has quickly subsided. A rapid convalescence has generally ensued, and the strength and looks have been regained almost as quickly as they were lost.

A still more rapid and violent description of the disease has frequently been observed, particularly in natives. The patient, apparently in his ordinary state of health, is going

* See their Letter to Dr. Meek, published in the volume of Reports of the Bombay Medical Board.

about his usual occupations, when the sensorium is in an instant invaded by violent vertigo and ringing in the ears (which has been compared to the humming of a thousand swarms of bees, the beating of all the drums in camp, or the roaring of our Coromandel surf), together with deafness and dimness of sight. The contents of the bowels are discharged, much diluted, at one very large evacuation, after which the white stools, characteristic of the disease, immediately appear; vomiting and the other violent symptoms at the same time set in; and the most extreme debility, and even death, are produced in the course of half an hour. The first appearance of the disease in His Majesty's 34th regiment was marked by a single case, which was fatal; on the two following days no attack was observed, and the alarm which was excited had begun to subside; but, on the day succeeding these, thirty-seven men were carried, in general nearly lifeless, to hospital, between eight or nine in the morning and midnight, and in that short space fifteen of them died!

In other cases the morbific cause has been almost instantly fatal. Several instances were heard of, at Hoobly and other places, of natives being attacked with the disease whilst walking in the open air; and, having fallen down, retched a little, and complained of vertigo, blindness, and deafness, they expired in a few minutes. Mr. Gordon reports to the Medical Board of Bombay* several cases precisely similar. At Bellary, a native tailor was attacked, as was believed, with this disease (for it was during its prevalence), and instantly expired, as it is said, with his work in his hands, and in the very attitude in which he sat when it came on. Captain Sykes, in a letter published in the work above alluded to, states, that "when the disease first commenced its ravages at Punderpoor, three hundred and fifty people are described to have died in one day, tumbling over each other lifeless in the public streets." Mr. Coates, on the same occasion, ob-

* See Reports, p. 82.

serves, " the number of deaths at Punderpoor in a few days were estimated at three thousand; and the patients are described as having been knocked down dead, as if by lightning." —It is only in the *nervous system* that we can reasonably look for an explanation of these occurrences.

Another very striking set of features of this proteiform disease still remains to be delineated; and although I have deferred, for the sake of perspicuity, the particular mention of them until now, they are amongst the most important, and most constant in occurrence. The burning pain in the stomach, increased on pressure, and the common circumstance of the ingesta being instantly rejected, are indicative of *inflammation* of that organ; and the appearances on dissection fully prove that that affection takes place, perhaps in every instance; for, whenever the disease has been of sufficiently long duration to allow time for appearances of inflammation to be formed, they are invariably found, not only in the stomach, but in the intestines. In many instances we have the most convincing proofs during life of the existence of inflammatory action in different parts of the frame. If the extreme depression of all the powers of life already described, and particularly if the state of torpor which follows the morbid cessation of vomiting, purging, and spasm, is not quickly concluded by death or natural sleep, the temperature, from being far below the natural standard, rises above it. If there is any vigour of the circulation left, the heat extends over the whole surface, and the moisture disappears; but if the powers of life are unequal to this, the trunk only becomes hot, the extremities continuing quite cold and moist; or, if life is at a still lower ebb, a very considerable accumulation of heat is felt in the axilla, while all the rest of the surface remains far below the standard of health. Under these circumstances also, the pulse is extremely quick (140 or upwards), sharp, and occasionally possessing a peculiar *irritated* thrill, which is strongly expressive of inflammation of vital parts; the tongue grows furred and dry; and, in com-

bination with these symptoms, many local appearances occur, leading to the same conclusion. In some cases the vomiting returns, and continues very frequent, rejecting every thing which is taken in for several days; and on dissection the villous coat of the stomach is found of a deep crimson hue throughout. In others there is fixed pain and soreness all over the abdomen; or, if the inflammation attacks chiefly the brain, there is occasionally muttering delirium, but more frequently coma, with deep and stertorous breathing, and suffusion of the conjunctiva, which quickly terminate in death. In cases which have lingered on for some time in any of these states, and even when the topical symptoms are scarcely at all evident, the appearances of inflammation on dissection are strongly marked, and quite sufficient to account for death.

This *inflammatory stage* frequently lasts several, even many days. If the depression of the vis vitæ is extreme, the secretions of bile and urine, and perhaps nearly all the secretions, continue suppressed throughout it. Under other circumstances, I have observed small quantities of high-coloured urine frequently passed, and black or green stools occur, without a favourable termination. On the commencement of the stage the pulse usually becomes rather more distinct, but it is more from increased sharpness than fulness; and we are presented with the remarkable phenomenon of acute inflammation and extreme debility prevailing at the same time, and indicating opposite modes of treatment.

It is probable that many of the cases from which the Bengal Medical Board have taken the above-mentioned description of the stage of reaction, have at least been accompanied with visceral inflammation, and particularly those which have led to the remarks in the paragraph preceding that description. In every *lingering* case terminating fatally, which I have witnessed, I have had sufficient reason to believe that inflammation was the immediate cause of death.

It is not only during the existence of the worst symptoms of cholera that this extreme tendency to inflammation appears,

but it may be perceived in a less degree after the favourable crisis, and during convalescence. Under these circumstances, I have observed a great number of diseases of this nature making their attack. In some enteritis has supervened, in others phrenitis, and in one the cessation of this former affection was immediately followed by symptoms of the latter. I have been informed of a case of cholera, by the practitioner who attended it, in which violent pain and other symptoms of inflammation in one of the kidneys supervened. The gentleman who was the subject, was very liable to disorder of the urinary organs; and it is remarkable that an excessive secretion of urine prevailed throughout the attack. The case terminated fatally in enteritis. Mr. Campbell, in an official report to the Medical Board of this Presidency, communicates a case of the epidemic, in which symptoms of hepatitis supervened on the fourth day, terminating in death on the seventh, from an abscess in the liver, which was found on dissection. I have also observed a considerable number of cases both of hepatitis and colonitis or dysentery occuring during convalescence from this disease; and one of pneumonia, which proved fatal by producing an abscess in the lung.

Mr. Whyte observes, that convalescents are subject to relapses, "differing from the original attacks, inasmuch as the pain is generally fixed; and most probably depends upon inflammation of some of the viscera of the abdomen; and these relapses are pregnant with danger*."

In a number of instances in the men of H. M. 84th regiment, who were convalescent from cholera, I witnessed inflammation, swelling, and ulceration, taking place about the punctures which had been made in bleeding; and in two of them that rare disease, inflammation of the vein from bleeding, occurred at the same time. In one of these cases death ensued, from the inflammation spreading up the vein to the

* Reports on the Epidemic.

large vessels within the chest, as was proved on dissection. In the other, the disease was partially arrested by dividing the vein above the puncture, but it continued to spread downwards; and on its finally ceasing, phrenitis immediately came on, and destroyed the patient. Dr. Girdlestone, who has written on this disease in 1782, observes, that "those who recovered were frequently affected with carbuncles, which would sometimes yield neither to bark, opium, nor wine*." More instances of this kind might be collected, but these are sufficient to prove the general fact; and to convince the practitioner, that, when he has carried his patient through the chief severity of the attack of cholera, he has not performed all his task;—he has still to obviate the remaining general tendency to inflammation.

The description of the more common and fundamental type of the epidemic is now completed. It will be perceived, that the disease presents an extreme variety, and perhaps unparalleled number of symptoms; and that it undergoes some remarkable changes, by which its appearances in some parts are rendered perfectly dissimilar from those which prevail in other parts of its progress. Hence it becomes a desideratum in every point of view to define its different stages; and it seems to afford us sufficient data to enable us to do this with some precision.

A number of slight and comparatively trifling symptoms have been detailed as occurring at the commencement of the disease, which may be said to constitute its *first stage*. These affections have been little noticed, but they are more worthy of our attention than any other part of the disease; for, by the discovery of its presence in this state, and the prompt application of remedies, we are enabled with ease, and almost with certainty, to crush it in embryo. This stage is indeed not unfrequently wanting, but there can be no

* "Essay on the Spasmodic Affections in India," p. 55.

doubt that a greater degree of attention, on the parts both of the patient and physician, than has usually been paid to it, would much more generally detect its existence.

It has already been more than once observed, that a striking exacerbation of the disease usually occurs on the accession of the spasms. This, then, will sufficiently point out the end of the first and the beginning of the *second stage;* or in cases where spasms do not occur, the severe vomiting, or the sinking of the pulse, will sufficiently mark the event.

A still more remarkable era is found in the cessation of the vomiting, purging, and spasms; or that fatal and delusive quiescence of the system, wherein all the diseased actions appear to cease, but without being replaced by the healthy actions of the frame, which are necessary to the continuance of life. These events clearly mark the end of the second and beginning of the *third, or last stage* of those cases which are rapidly fatal, and conclude without any considerable symptoms of reaction.

Two more divisions are necessary to complete this classification of the phenomena of the disease. The first of these, occurring only in the more protracted cases, will consist of that state which is chiefly characterized by *inflammation.* Its commencement will usually be marked by the transition from the cold and torpor of the third stage to morbid heat, with various marks of topical affection; and without the general revival and improvement which attends the return to health.

Lastly, the *stage of reaction* will commence with the favourable crisis, and include all those febrile and other increased actions which precede and accompany convalescence.

We cannot expect, however, generally to find the regularity which is here assumed. The various stages will be found to run into each other by imperceptible gradations. The spasms will frequently be found to prevail in some degree in the third stage. The appearances of inflammation will often be variously mingled with the other symptoms, and exist in a greater or less degree throughout the disease. It will occa-

sionally be difficult to distinguish between the stage of inflammation and that of general reaction, as both are attended by fever. The topical symptoms will however, when present, point out the former. It will be attended by a greater degree of general disease than the simple reaction; for one is a highly dangerous stage, usually terminating in death, whilst the other appears to be owing to the salutary efforts of nature, and generally ends in convalescence. And in particular, the inflammatory stage will be marked by a want of that increase of the fulness of the pulse which characterizes the other; for, however paradoxical it may appear, it is found that the tendency to inflammation in cholera is nearly in an inverse proportion to the force of the circulation, or at least to the fulness of the pulse.

It will be useful to present an abstract of the more important and usual symptoms of each stage of the disease; which will contain a brief recapitulation of its phenomena, as far as they have yet been detailed.

First Stage.

Pulse soft, rather small, and frequently quick; surface below the natural temperature and moist; countenance pale and anxious; giddiness; headach; ringing in the ears; tremor; languor; depression of spirits and sense of debility; nausea, sometimes vomiting; griping of the bowels; some loose stools of natural colour, afterwards greyish; pale urine; thirst.

Second Stage.

Pulse very small and weak, generally quick; surface cold and blue; respiration hurried and oppressed; countenance sinking rapidly; extreme anxiety and debility; spasms of the voluntary muscles; frequent vomiting of whitish or transparent fluid, mixed with mucus; frequent purging of white watery fluid, with flakes of mucus; extreme thirst; oppression and burning pain at stomach, increased on pressure;

griping at intervals; no secretion of urine; little secretion of saliva; copious cold sweat; voice hoarse and weak.

Third Stage.

Pulse quick and extremely small, fluttering or imperceptible at the wrist; coldness and lividity of the surface increased; respiration oppressed, occasionally stertorous; stupor; anxiety; facies hippocratica; vomiting, purging, and spasm, nearly or entirely ceased; extreme thirst; no secretion of urine; mouth dry; skin moist, shrunk, and shrivelled; eyes glassy, or covered with a film; loss of voice; tinnitus aurium; blindness and deafness frequently; diminished sensibility of the surface; death.

Inflammatory Stage.

Pulse very sharp, extremely quick and small; surface wholly or partially hot and dry; tongue furred and dry; sunken countenance; various symptoms of gastritis, enteritis, or phrenitis; the pulse disappears, and death generally ensues.

Stage of Reaction.

Begins after sound sleep, or other symptoms of a favourable crisis; pulse quick and generally fuller than natural; skin warm or hot; perspiration; excessive secretion and evacuation of bile, and of feculent and watery matter from the primæ viæ; return of the secretion of urine; striking improvement in the looks; agreeable sensations; convalescence.

But the practitioner will not find the train of symptoms here delineated, or any other, a true picture of the disease in every case. He will scarcely even find the whole of the more prominent symptoms present in the generality of cases. Certainly the more rapid and violent cases exhibit considerable uniformity, and the latter stages of all fatal cases are

very much alike, or differing but in the manner which has already been described; but in its less fatal forms, and its earlier stages, the disease presents an infinite variety of appearances. It was a common remark among the medical officers at Bellary, that no two cases were found alike. In a considerable proportion there is no appearance of spasm in any part of the system. In many there is no purging; in some no vomiting; and in others, neither of these symptoms. In one class of cases a very considerable morbid exertion of power appears in the muscles both of voluntary and involuntary motion, in the organs of secretion, and in the circulating system: in another class, there is little or no increased action, but on the contrary a general cessation, more or less suddenly occurring, of all the moving powers of life.

SECT. II.

OF THE MILDER FORM OF CHOLERA.

Some of the discrepancies which have just been noticed must be ranked among the anomalies that are constantly occurring in all diseases; but the chief of them may be referred to general principles, which will afford some insight into their causes. The severe form of the disease, such as has already been described, is chiefly characterized by *diminished action* and suppression of functions—as extreme debility of the circulation and animal functions, coldness of the body, and arrestation of the principal secretions. The most striking variations from these common appearances have been observed in a set of cases which are chiefly marked by the preponderance of *increased action;* and consequently exhibit the very reverse of these symptoms.

Mr. Curtis, who witnessed this epidemic during its prevalence in 1782, observes on one occasion: "About a third of these cases were evidently connected with bilious colluvies; and in these there was no great sinking of the pulse or dimi-

nution of heat; and the spasms were confined to the legs and feet. There was some fever, and the pulse was frequent as well as feeble. The tongue was commonly foul, and the countenance yellow: the abdomen tumid, or tender to the touch, with more or less of griping and bilious discharge by stool*."

Dr. Burrell, surgeon of H. M. 65th regiment, in a report to the Medical Board of Bombay†, after describing the low form of the disease, says, "On the 22d instant, when the men had been duly warned of danger from not reporting themselves sooner, I got into hospital a different description of cases, *viz.* men with a full pulse, hot skin, constant vomiting of white matter like thick conjee: seldom any purging; if it existed it was like the matter vomited. Bleeding was used in every case with so much success that I have no hesitation in recommending its adoption.

"The first symptoms in the attack were languor, with occasional pains and sense of numbness in the extremities, violent headach and thirst; shortly there ensued nausea, vomiting of slimy matter, weight over the præcordia, with griping in the bowels, small stools of white slimy matter; no appearance of bile from the stomach or bowels. The spasms followed, in many cases so violent as to require six men to hold the patient. If relief was not immediately given, it is astonishing how soon the system sinks under the attack, marked by the ends of the fingers and toes getting cold, pulse and motion of the heart ceasing, with a livid mark round the eyes.

"From this state some men recovered by the stimulating plan, although they had been in that condition from six to twelve hours; but it is to be looked upon as one of the most dangerous symptoms of the disease." The Board in their Preface also mention further instances of heat of skin, and other marks of increased action, in the early stages.

* Diseases of India, p. 69.

† Reports on the Epidemic, p. 7.

Mr. Campbell, in a letter to Mr. Scarman, from Seroor, which was circulated in one of the divisions of this establishment, observes:—"The cases which terminated favourably, presented very different symptoms (from the low form of the disease). As I saw the men immediately after they were attacked, they came to me with a quick, *full* pulse, and in several instances pain in the head; there was no sweating; they in general complained of a numbness in some part of the extremities, before the spasms came on; vomiting and purging of a whitish matter next made their appearance, and the cramps became general. In several cases *bile* appeared from the first in considerable quantities in the egesta; and these were more manageable than those in which no bile was ejected, although the spasms and vomiting (the most distressing symptoms of the complaint) were equally violent.

Mr. Whyte reports to the Bombay Medical Board*:—"In conclusion I am happy to inform you, that for the last three days the disease has been evidently on the decline, and during that period most of the cases have assumed a different and much milder type, and comparatively are little dangerous. It approaches somewhat to fever; the patient complains of severe pain in the legs, sometimes vomiting a watery fluid, and sometimes bile; but in every case the heat, so far from being diminished, is increased, and the pulse is full, though little increased in frequency. The disease is attended with this advantage, that in its first appearance it is alarming. The pain in the abdomen and the spasms in the legs are pretty severe; but besides he is possessed with emotions of fear and alarm, greater than the symptoms ought to give rise to, and for which he, when asked the reason, is totally at a loss to account. A large dose of calomel and opium in every case has been sufficient, and generally in a few hours he goes home quite well." On a subsequent occasion he observes:—"The disease continues to present a

* Reports, p. 68.

milder aspect, and now occurs but rarely: loss of pulse and coldness are seldom observed; and often it first shows itself by a *severe* pain in the abdomen, attended with cramps of the lower extremities; sometimes by a sudden giddiness and confusion, loss of memory and vomiting, attended also with cramps: indeed, but for these cramps I think it would be impossible to distinguish this stage from fever, at the beginning: and these cases are hardly attended with any danger*."

Mr. Mackenzie, of this establishment, reports to the Medical Board:—"In many the disease is said to have been ushered in by bilious vomiting, but this has been soon changed to a watery fluid." Mr. Hood reports the same occurrence. Mr. Geddes also reports to the Board the general occurrence of full and quick pulse and hot skin in the beginning, forming cases precisely similar to those detailed by Dr. Burrell.

Mr. Duffin, surgeon at Vellore, in a report to the Medical Board, gives the following account of the disease as it prevailed there and at Arcot, in 1787. "The patients are generally seized with a nausea, frequent heats and chills, and numbness and uncommon sensation, as they express it, of different parts of the body. Then came on cold sweats, severe gripings, and mostly a purging of bilious colluvies, appearing often in a ferment like yeast, and sometimes not unlike it in colour. Retchings to vomit, often bilious, and at other times scarcely any thing is brought up but what is drank. There is intense oppression of the præcordia and difficulty of breathing," &c. &c. Mr. Davies, "Head Surgeon," who, it appears, was sent up from Madras on the occasion here alluded to, to investigate the cause of the epidemic at Arcot, reports:—"On my arrival at Arcot, I found in what is called the epidemic hospital, three different diseases, *viz.* patients labouring under cholera morbus; an inflammatory fever with universal cramps; and a spasmodic affection of the nervous system. The last had proved fatal

* Reports, p. 23.

to all who were attacked with it." Mr. Duffin does not appear to have made these distinctions; and, after the evidence which has been adduced, we cannot doubt that these three diseases, which Mr. Davies mentions, were one and the same.

My own experience has also been very conclusive with regard to the sthenic form of the disease. I have found a very considerable number of cases exhibiting, singly or in partial combination, every possible degree, and almost every kind of increased action of which the system is capable:— spasms, such as not to fall short of the highest degree of tetanus; retching and spasms of the intestines equalling colica pictonum; very full, hard, and quick pulse*; hot skin and flushed surface; evacuations of bile both by vomiting and stool, from the commencement of the attack; and, finally, I have seen some of these cases passing into the low form of the disease—the circulation passing suddenly from extreme strength to extreme weakness; the skin from being hot and dry becoming deadly cold, and bathed in sweat; and the increased flow of bile succeeded by white stools and vomiting, clearly indicating the total suppression of that secretion. One inference from these facts is plain—however opposite these two forms of the disease may appear, there is no essential or generic difference between them.

Some difference in cause must, however, exist to produce this difference of effect: and there is one general observation which holds good with regard to all the increased actions, with the exception of inflammation, that sufficiently points out what this difference is—*they are found to indicate a smaller degree of the disease than that which gives rise to the opposite affections.*

The extracts which have been made to prove the existence of affections of this kind, also prove that they are symptoms of a less dangerous form of the disease. Mr. Whyte dis-

* One of them was actually the largest and strongest pulse I ever felt; nevertheless it soon sank, and the case was lost.

tinctly observes, that the cases which he describes were "of a milder type." He was uniformly successful in their treatment; and Dr. Burrell saved nearly the whole of his cases of this kind; yet the plans of treatment which these gentlemen employed were extremely different from each other. Mr. Campbell's letter expresses that he had been successful in these cases only. On the decline of the epidemic in the 34th regiment, Mr. Allardyce observed, and reported to the Medical Board, many cases attended with bilious discharges throughout; and he constantly found them mild and tractable.

Mr. Curtis details eight cases of the low form of this disease, marked by the suppression of bile; five of which terminated fatally, and two more were with great difficulty saved. He then observes, "The cases which appeared after this were all of a different nature, much less severe, and none turned out fatal. They were all of them combined with bilious accumulations, and in patients where this diathesis was visibly present at the time. The evacuations, both by stool and vomiting, were bilious; and the purging was attended with griping rather than tenesmus. The countenance, in place of becoming pale and livid, was sallow*.

Mr. M'Cabe, depot surgeon at Poonamallee, informs me, that he has found the cases which to common observation might appear the most desperate — those which were attended with spasms and retching of extreme violence — actually among the most tractable; a valuable remark, which my own experience fully confirms. Dr. Burrell saved eighty-eight out of ninety of his later cases; and in his general description of them, he says that the retching was constant, and the spasms often so violent as to require six men to hold the patient on his cot. On the other hand, nothing can be more evident than the intractable and fatal nature of those cases in which the pulse, instead of rising, sinks at once; in which

* Diseases of India, p. 66.

there are no spasms, and scarcely any vomiting or purging; and in which not only the secretion of bile, but the secretions in general appear to be entirely suspended.

In almost every instance in which the cases characterized by increased action are mentioned, it is at the same time distinctly observed, that they occurred during the decline of the epidemic, when we must suppose that the morbific cause existed in a diminished degree; and I have generally observed, that when the attacks were of rare occurrence, they assumed more or less of this form, from which the same inference is to be drawn. It is also evident, that the increased actions prevailed chiefly at the beginning of each case; consequently when the disease had not attained its maximum of violence. And, if any other evidence was wanting to show that these affections were owing to a comparatively small degree of morbid cause, it is found in the appearance or reappearance of that class of symptoms, in every case, at the favourable crisis, when the system is passing from the extreme of disease to health; for, excepting the spasmodic affections and inflammations, the stage of reaction exhibits all the increased actions of cholera.

The total absence of bile from the evacuations, in the early stages and fatal cases of the common form of this epidemic, has led to a common belief in this country, that it is essentially different from the disease, which, since the days of Hippocrates, has received the name of *Cholera*. This opinion is supported by the authority of Cullen, and perhaps all the older writers; for they seem to have unanimously considered the "irritation of acrid bile in the primæ viæ" as the proximate cause of the disease. But obedience to authority in despite of evidence, so far from being a virtue, becomes a failing. However unwillingly we may dissent from authority so venerable as that of Cullen, when we see a long train of peculiar symptoms, perfectly similar to that which he describes, arising entirely without the cause to which he attri-

butes them, we are compelled to believe that he has fallen into the common error of assuming one of the most prominent symptoms of a disease as its proximate cause.

Dr. James Johnson has considered this disease as identical with cholera morbus, and has very successfully combated the opinion that bile is the proximate cause; but he has attempted to do away the distinction between them by a supposition which is not generally admitted — that the excessive flow of bile is, in both forms of the disease, a symptom only of the more advanced stages. We have much evidence that this symptom generally occurs, even in the beginning of European cholera; but, from instances which have been produced, it is clear that the same thing not unfrequently happens in the milder degrees of the epidemic; consequently it affords no grounds of distinction; on the contrary, this agreement presents the last mark of identity between Indian and European cholera.

Our extensive experience in the epidemic has indeed brought to light various symptoms which have been rarely, and some of them perhaps never, noticed in common cholera; but this may be clearly attributed to the wide prevalence, and greater violence of the disease. The cases which have been noticed, in which life was almost instantaneously extinguished, cannot be looked upon in any other light than as the most intense degree of the disease. The white stools which are so common in the usual form of the disease in this country, appear occasionally in the other. Dr. Darwin relates a case of cholera, occurring in England, in which large quantities of watery fluid, mixed with bile, were discharged in the beginning; but "after the yellow excrement was voided the fluid ceased to have any smell, and appeared *like curdled milk*, and then a thinner fluid and mucus were evacuated*." From the description of cholera given by Celsus we draw the same inference; and at the same time

* Zoonomia, vol. i, p. 414.

we perceive, that almost every observation which he makes concerning it presents a strong mark of identity with this epidemic: "Nam simul et dejectio et vomitus est; præterque hæc inflatio est, intestina torquentur, bilis supra infraque erumpit, primum aquæ similis, deinde ut in ea recens caro lota esse videatur; *interdum alba*, nonnunquam nigra vel varia. Ergo eo nomine morbum hunc χολεραν Græci nominaverunt. Præter ea vera quæ supra comprehensa sunt, sæpe etiam crura manusque contrahuntur, urget sitis, anima deficit. Quibus concurrentibus non mirum est si subito quis moritur. Neque tamen ulli morbo minori momento succurritur*."

The description of cholera given by Sydenham very closely corresponds to the Indian disease, and is important as it takes particular notice of the occurrence of inflammation; a fact which has been scarcely noticed by authors, and is extensively denied in this country:—"vehement vomitings and difficult and painful dejection of ill-conditioned fluids, agony and inflammation of the intestines and abdomen, cardialgia, thirst, a quick pulse often small and unequal, heat and anxiety, nausea and colliquative sweat, spasms of the arms and legs, fainting and coldness of the extremities, which terrify the bystanders, and often kill in twenty-four hours."

The suppression of the secretion of urine in cholera does not appear to have been noticed by modern authors; though it is a most important symptom, proving that the suppression of bile does not arise from a local or a partial, but a general cause. It was, however, known to Hippocrates, and observed by him in the bilious form of cholera:—"Eutychides ex cholericis affectionibus, in cruribus ad nervorum distensionem desivit, una cum secessu deorsum. Bilem multam abunde coloratam vomuit ad tres dies et noctes, valde rubram: et impotens erat, et anxius. Nihil autem continere poterat, neque ex cibis: *et urinæ suppressio multa* ac transitus deor-

* Lib. iv, cap. 11.

sum: per vomitum fex mollis prodiit et deorsum quoque erupit*."

It appears therefore that there is no constant symptom on which to found a distinction between European and Indian cholera; and if we rest it on the usual absence of bile in one, and abundance of it in the other, as well might we divide this epidemic into two diseases on account of its producing violent spasms in the muscles of one subject, and none at all, but, on the contrary, extreme debility approaching to paralysis in those of another. But these arguments are superfluous. It is sufficiently evident that cholera morbus and the usual form of this epidemic are but different degrees of the same disease; and that the former is the lesser, and the latter the greater.

As, however, the preponderance of increased action, and particularly the excessive secretion of bile, clearly mark a milder and less dangerous form of the disease, it is highly desirable, with a view to practice, to preserve the distinction. The term *Cholera* is certainly improper, in so far as it conveys a wrong idea of the nature of the disease; but, until its pathology is determined, we are not authorized to change it for another, which may prove equally erroneous. The purpose will be sufficiently answered, and at the same time the most important feature of distinction clearly expressed, without any hypothetical assumption, by terming the European type, including all cases of the Indian disease chiefly marked by increased action of any kind, *Cholera Mitior;* and the common form of Indian cholera, *Cholera Gravior.*

The regularity which we are led to expect from descriptions of diseases (and which is in some degree necessary to their perspicuity), rarely occurs in practice; and accordingly we shall frequently find it difficult or impossible to draw the line of distinction between these two forms of the disease. They will be found running into each other by imperceptible grada-

* De Morbis Popularium, tom. i, p. 794.

tions; they will frequently, nay perhaps invariably, in cases of the former which terminate fatally, commence in the first form and end in the last; and they will very commonly be found perfectly mixed in the same subject, at the same time; for the heart, or any other part of the system shall be affected in the extreme degree which produces diminished action, whilst the liver or some different part experiences, at the same time, only that which gives rise to increased action. It will be useful to adduce a strongly marked case of each kind, occurring in similar habits, of the common strength and fulness, and both terminating favourably; and to place them in opposition to each other. The symptoms in which they will most remarkably differ will be as follows:—

CHOLERA MITIOR.	CHOLERA GRAVIOR.
GENERAL CHARACTER.	GENERAL CHARACTER.
Increased action.	Diminished action.
PARTICULAR CHARACTERS.	PARTICULAR CHARACTERS.
Excessive secretion of bile throughout.	Entire suppression of bile until the favourable crisis.
Violent spasms of the voluntary muscles.	Slight spasms, or none.
Moderate debility of the animal functions.	Extreme debility of the animal functions.
Full and strong pulse.	Extremely weak pulse.
Hot skin and flushed face.	Cold skin and sunken face.
Violent and frequent retching, spasms in the intestines, and purging.	No spasms in the intestines; not more than one or two evacuations by vomit or stool.

Such will be the appearances in the early stages of each case. If the disease is not quickly arrested in the first case, the increased actions will be superseded by symptoms of an opposite character; consequently it will assume, in a great

degree, the form of the second. On the occurrence of a favourable crisis, also, the distinctions will in great measure cease: in both there will be excessive secretion of bile, heat of skin, and a pulse above the natural standard, both in frequency and force.

We have seen that a difference in degree of the principal external morbific cause appears to be the chief cause of this variety of phenomena; for the severe form is found to prevail chiefly during the early and middle periods of the prevalence of the disease at any place, and the other after the favourable crisis (if the term is admissible) in external circumstances, and when the epidemic visitation is declining; but both forms are frequently met with under the same external circumstances; for at the same time and place one class of persons is found to suffer from cholera gravior, whilst another class experiences only cholera mitior. This difference is to be attributed chiefly to variety of temperament, which in this, as well as in all other disorders, is a fertile source of variety of disease. It was early remarked by the Medical Board of Madras, that the spasms were most severe in the most robust subjects; and the whole of our experience has tended to confirm this observation, and to establish the position, that the whole of the increased actions of cholera are (as might a priori be expected) more prevalent in such habits, whilst the opposite class of affections vastly preponderates in delicate constitutions. Between the European and the native of India there exists a very striking difference of temperament; for the latter is greatly more weak, lax, and delicate than the former: accordingly it has been found, that the low form of the disease is most prevalent among natives, and the other among Europeans. We are not however to attribute this variety of type in the epidemic entirely to difference of temperament, to the exclusion of a difference in the external influence; for the cases with increased action, which Mr. Whyte describes, occurred in a corps of native infantry, and are very similar to those mentioned by Dr. Burrell, as appearing in the 65th

regiment. They were all clearly owing to diminution of their great remote cause; for they occurred at the same time and place, in immediate succession in both instances to others of an opposite nature, and previous to the general return to health.

As it has been said that the preponderance of increased action marks a milder form of the disease, and that the European constitution more frequently exhibits that phenomenon than that of the native, it follows, that the disease should be less fatal in the former than in the latter class of persons. This, also, has been very generally observed; and there can be no doubt that, but for the intemperate habits of the Europeans in India (in which they differ from the native as remarkably as in the physical strength), it would be comparatively harmless to them; for this unfortunate way of life produces a strong tendency to inflammation, which, though an increased action, is highly dangerous, and, as will be subsequently shown, does not appear to obey the same laws with the other increased actions. In fact it would appear, that increased action in general, whether arising from a smaller degree of morbific cause, or a greater vigour of the system, is equally indicative of less disease than its opposite. It is evident that the quantum of disease in any case must be not only in proportion to the quantity of external cause, but in inverse proportion to the power of resistance against it inherent in the frame. Like the sensations produced by heat and light, it bears a relation to the previous state of the system or organ affected, as well as to the degree of its cause. The most vigorous and healthy persons are incontestibly the least subject to this epidemic, or, when attacked, to its more dangerous forms; and it is probable, on the foregoing principles, that these previous states of the system, by affording resistance to the morbific influence, reduce the disease to its milder form, and thus chiefly give rise to the same phenomena as those which attended the diminution of the great cause of the epidemic.

It appears, therefore, that the great and ordinary diversities in the phenomena of cholera, which arise from unusually increased or diminished action, are principally referible to different degrees of disease. Some others of a less general and important nature remain to be noticed.

SECT. III.

OF THE MORE INFREQUENT AND ANOMALOUS SYMPTOMS OF CHOLERA.

The absence of spasm in many cases has already been mentioned; the following extract from a report made by Mr. Conran, of the 5th native cavalry, to the Medical Board of Madras, will show how general this occurrence occasionally is. After detailing twenty-one cases which had occurred in his corps, and observing that he had supplied medicine to some hundreds of the natives of Arcot, he says:—"The epidemic, as it has occurred under my observation, is precisely such as has repeatedly been described, with one remarkable difference, nearly the total absence of spasm or cramp in every case; unless the diminished circulation in the extreme vessels should be considered as the effects of spasm in these vessels, like the imaginary spasm of Cullen, in the cold stage of fever." He enumerates the other usual symptoms, and adds:—"I have purposely placed first the rapid depression of the vital powers, because it seemed to me the most essential part of the disease; the vomiting and purging are but secondary compared to it. Many patients died having vomited and purged but two or three times; which, under no ordinary circumstances, could be sufficient to exhaust life; and in one of the worst cases which came under my observation, there was no vomiting at all." Hence it appears that these cases were, in other respects as well as in the absence of spasm, marked by unusual depression of

vital energy, and consequent absence or diminution of all action, whether healthy or morbid. Mr. Duncan, another medical officer, reports, at the same time and place, the same remarkable absence of spasm; and likewise in natives.

The absence of purging has also been remarked in so many instances as to render it somewhat more than a casual occurrence. Dr. Girdlestone, in his description of this disease, makes not the smallest mention of this symptom; a circumstance which is remarked by Dr. Clark. We are not, however, to conclude from hence that the disease, on that occasion, was universally unattended by purging; for we know, by the accounts of Curtis and others, that this was not the case; and no doubt can be entertained that the epidemics which prevailed in this country in 1782 and 1787 were identical with that which exists at present.

It would appear that when the spasms are very violent and general, and the retching extremely distressing, the purging is little remarkable, and frequently altogether absent. This was evidently the case in Dr. Burrell's practice, and still more remarkably in Dr. Girdlestone's; and, from observation, I am likewise led to believe it of common occurrence.

Vomiting, though one of the most constant symptoms, has likewise been frequently observed to be altogether absent. Mr. Wyllie, a very intelligent medical officer of this establishment, observes, in a report to the Board;—"I have seen so many cases without vomiting, that I do not consider its presence at all necessary to characterize the disease." The same gentleman has also observed the absence of spasm of the intestines so constantly, in the course of a very extensive practice, that he considers that symptom as a mark of distinction between the epidemic and common cholera. Mr. Shedden likewise reports to the Board the frequent occurrence of cases without vomiting. If the absence of vomiting is attended by other marks of a high degree of disease, it cannot be looked upon in any other light than a most fatal symp-

tom; indicating, in general, that the system is incapable of the smallest exertion, even in that great centre of life—the stomach and its neighbourhood. Mr. M'Cabe informs me, that he has been led by experience to look upon the continuance or return of the irritability of the stomach in the worst stages, as a favourable symptom. In fact, any deviation from the atony of the third stage must be preferable to its continuance, for it appears to tend directly, and only, to death.

In a second and very fatal visitation of the epidemic, experienced by Brig. Gen. Pritzler's force, I am informed that vomiting, purging, and spasms were very frequently, in a great measure, if not entirely absent; all the powers of the system failing at once, and death commonly ensuing in three or four hours from the attack. Such cases appear to consist, almost exclusively, of the *third stage* of the disease; the first and second, consisting of its lesser degrees, being cut off by the concentrated form of the morbific cause.

Trismus has been observed in a considerable number of instances. It does not appear to have indicated any thing very remarkable. The jaw has frequently continued locked for several hou s.

Symptoms approaching to hydrophobia have also been not unfrequently remarked. Sir Thomas Sevestre, assistant surgeon of this establishment, reports the following case to the Medical Board:—"Aminama, a native woman about 50, was brought to me about 6 o'clock in the evening, in the advanced stage of cholera spasmodica, with which she had been attacked about noon. Her pulse had entirely ceased at the humerus; she passed some blood in her evacuations downwards; the spasms extended from the extremities up to the neck and face, forming decided trismus; and when we succeeded in pouring any liquids into the mouth, they were partly rejected from inability to swallow. She constantly asked for water; but had a dread of the pain attending deglutition. Æther and other antispasmodics were repeatedly given, as well as

stimulating substances applied externally; but the disease in this instance continued with such rapidity, that her expected death was reported to me on the following morning." Mr. Stewart also reports, in the case of a gun lascar, the occurrence of "convulsion occasioned by the attempt to swallow liquids, exactly resembling that which occurs in hydrophobia; but there was no horror of water. The disease appeared chiefly to affect the chest. On dissection the right lobe of the lungs, and all the costal pleura, were found much inflamed. The inner coat of the stomach and all the intestinal canal, were also in a high state of inflammation." In one instance I have remarked spasms of the muscles of deglutition constantly brought on by the attempt to swallow. The case was one of those which are marked by increased action, and terminated favourably.

Hiccough is of common, though not general occurrence: and, it would appear, chiefly during recovery. Mr. Corbyn remarks:—"It is not a dangerous symptom in this disease, for there was hardly a patient recovered without suffering this spasmodic irritability." It seems to be much more frequent in natives than in Europeans.

In the general spasmodic state of the system, which prevails in this disease, it might be expected that cramp of the stomach would occur. It is not, however, a common symptom. Mr. Wyllie reports its occasional occurrence, and remarks its being a highly dangerous affection. It is evident that the stomach, in general, is affected only with the clonic spasm, producing vomiting.

Dr. Girdlestone remarks, that "the muscular spasms in some were only clonic or convulsive;" and in the most violent cases of spasm, it would appear that this affection occurs; as we may infer from the circumstance, so frequently noticed, of many men being required to hold the patient on his cot: the tonic spasm renders the body rigid, and does not usually produce excessive struggling. I have distinctly noticed the

occurrence of convulsions, particularly in a patient who was subject to epilepsy; but in this instance there appeared to be a combination of that disease with cholera. The clonic spasm has been observed to be usually connected with *insensibility*; it is therefore not surprising that it should not prevail much in cholera, when the mind is generally entire.

Hemiplegia has been noticed as a consequence of cholera in one or two instances. The partial or total loss of power of the voluntary muscles is very common in the last stages.

Syncope is enumerated by Celsus and Cullen among the symptoms of this disease. But it is certain that perfect syncope is not one of the ordinary symptoms of this epidemic, notwithstanding the aggravated form of the disease which it exhibits. It is however of occasional occurrence; and not unfrequently gives the first intimation of the presence of the disease, particularly in its worst forms.

Delirium is not an unfrequent symptom; and it is not uncommon for patients after recovery to have nearly lost the recollection of all that happened during their illness. Perfect delirium, when it occurs, appears to be owing to inflammation of the brain; but, as has already been observed, that affection is more commonly attended by coma.

Cardialgia is frequently noticed as a common occurrence in convalescence. It would appear to be nothing more than a continuation or return of the heat and pain at the stomach, which prevail at the height of the disease (and which have frequently been denoted by this term), owing to some remains of inflammation of the stomach.

Pain and soreness of the muscles which have been affected with spasm, are common during convalescence.

Tenesmus and strangury are both noticed in the description of the disease by the Bengal Medical Board*; and have occasionally (particularly the former) been mentioned in the official reports of the other establishments. In the excessive irritation which exists throughout the system, it is not sur-

* See Bombay Reports.

prising that these symptoms should appear; the second of them, however, I have scarcely ever seen; the other appears to be in a great measure owing to the excessive peristaltic motion of the intestines, by which a fresh portion of fluid is constantly carried down into the rectum; but it may also, as in dysentery, arise from irritation, for it is frequently attended with a discharge of mucus, as well as in that disease. Mr. Whyte reports:—"the tenesmus now becomes constant, although nothing is discharged but the fluid above mentioned, and a substance like the congealed white of an egg*."

Bloody stools are also not of uncommon occurrence. In the short description of the disease given by Celsus, and transcribed above, they appear to be noticed, and they have frequently been observed in this epidemic. In one case which I have witnessed, a large quantity of blood was passed by stool, and extensive gangrene of the small intestines found on dissection. The Medical Board of Bengal likewise mention bloody stools as an occasional symptom; and Mr. Ogilvy, of this establishment, reports several cases in which "the evacuations were almost wholly composed of pure blood."

The evacuation of round worms (lumbrici), both by vomiting and stool, is a very common occurrence; so much so as to lead to a suspicion with some, that they were connected with the disease, and that relief was experienced on their being discharged. This however is not probable. The fact only shows how very frequently these animals are inmates of our frames, without their presence being suspected; and that they had been expelled by the violent action of the stomach and intestines. It seems much more common amongst natives than Europeans. Mr. James Orton has seen, ejected by vomiting in this disease, one of the larvæ (resembling a caterpillar) represented at p. 48, vol. vii, Edin. Med. and Surg. Journal, fig. 1 and 8; and quotes the observation of

* Reports, p. 17.

Dr. Bateman, that "it is probable that this is not one of the most rare of the insects which occasionally infest the human frame."

Weakness and loss of the voice have already been noticed. The latter appears occasionally to occur previous to the loss of the other powers of voluntary motion. A case is recorded of a lascar who was suddenly attacked with the disease, and instantly rendered speechless; he fell down and was observed endeavouring to attract the attention of his comrades, who stood near, by picking up and throwing small stones towards them.

It is remarkable that the veins of the surface are frequently noticed to be full, even turgid, at the same time that the circulation is extremely weak. If bleeding is attempted, the veins of the arm quickly empty themselves, after which it is frequently found difficult or impossible to draw more blood.

Rigor appears to be an occasional occurrence in the beginning, particularly of the milder cases. I have not looked for this symptom, either in practice or reference, but have seen it complained of in one instance. In fact, this truly proteiform disease seems occasionally to assume all the characteristics of fever. This resemblance, as pointed out by Mr. Whyte, has already been noticed; Mr. Robertson places it in a still stronger point of view:—"This disease displays great variety in its mode of attack, which is certainly influenced by the constitution of the subject. Thus, amongst our admissions into hospital, I have observed, that men who had been exposed to the remote or exciting causes of fever, were seized with a cold chill or shivering, and a great weakness, they said, such as they never felt before, with sometimes a loss of sight; these were succeeded in a short time by a hot skin, quick and tolerably full pulse, acute headach, intense thirst, sickness and sometimes vomiting; great oppressions in the chest, and a tendency to spasmodic twitching there, without much affection of the bowels*."

* Reports, p. 39.

Yellowness of the eyes and general jaundiced appearance have occasionally been noticed. Mr. Daw has observed this affection as a common symptom, at the beginning of the disease*. I have witnessed it, in one of the cases attended with evacuations of bile, from the first, preceding the attack a day or two, and becoming extreme during convalescence.

A remarkable sense of pricking in the extremities is frequently found to precede the spasms, and even to occur independent of them. Mr. Boyd, in enumerating the symptoms of the disease, in a report to the Madras Board, states, that "a prickly sensation generally pervades the whole body." In the case of an European, who was recovered with great difficulty, I observed great complaints of a painful pricking of the skin; which the patient supposed to be owing to the breaking out of a rash, but on examinanation no eruption could be found. It occurred whilst he was slowly recovering, and was still suffering from inflammation of the stomach. Mr. Annesley informs me that he has met with a similar case in the General Hospital at Madras; the patient complaining much of *prickly heat*, though no eruption could be perceived. A gentleman of this establishment, in a report to the Medical Board (which I cannot immediately refer to), mentions the frequent occurrence of itching of the skin, during convalescence; arising apparently from the same affection. It is probable that these curious symptoms are of common occurrence, but from their trifling nature are generally overlooked; for in a short account of the disease, quoted by the Medical Board of Bombay from an old native work, they appear to be mentioned. The whole of the description is worthy of being transcribed. "Symptoms of the disease named *Visoochi*. Faintness, purging, vomiting, thirst, piercing pains in the bowels (as if thrust through by a spear), vertigo, spasms or knots, yawning, sensation of internal heat, tremors, pain at the pit of the sto-

* Reports, p. 34.

mach, violent headach, retention of urine, coma, restlessness, *pricking pains in the body*."

The following extracts from reports of some of the head men in Malabar and Canara, to the magistrate of the districts, regarding the disease, may not be unworthy of notice, as consisting of observations wholly uninfluenced by theory.

"October 7, 1818. From the Bunnawassi Peischcar. Symptoms — Griping of the belly; turning of the head; a great heat on the body and burning in the palms of the hand and feet first, and then the whole body turns very cold, and senseless.

"From the Soonda Tassildar. Symptoms — Pains in the side of the belly; burning in the belly, rising to the throat; breathless; arms and legs cold.

"From the Ankola Tassildar. Symptoms—Once or twice vomiting and purging. *From the feet the patient feels a kind of sensibility which rises to the head, like venom;* the arms and legs then get cold, and senseless; he feels great thirst."

From these accounts it appears, that vomiting, purging, and spasm were not very remarkable, as the two former are mentioned as trifling, and the latter not at all. The sensation which is observed as arising in the feet, is too remarkable to be passed over without further notice, as something of that kind seems to be of general occurrence. Dr. Curtis, Dr. Burrell, and others, mention pains, sense of numbness and other uncommon feelings, in various parts of the extremities; and I have witnessed these sensations preceding the spasms. They appeared to resemble that painful affection produced by pressure on the nates in sitting, when the foot is said to be *asleep*. It is probable that they occur frequently in cases when there are no actual contractions of the muscles. Dr. Peyton remarks, that the native patients with cholera, complained much of their limbs, though he could see little or no appearance of spasm in them.

Dr. Cullen observes, that the spasms in cholera are communicated from the intestines to the abdominal muscles, and from thence to the extremities; but this opinion has probably originated in theory. It has been generally remarked, on the contrary, that they commence in the extremities in this epidemic, and from thence are gradually communicated to the muscles of the abdomen and chest. This progressive motion, if true, is remarkable, and coincides with the course of the sensation described by the Tassildar; I cannot however speak from experience on the point, for I have found the spasms very desultory and irregular, and in all stages chiefly occurring in the extremities.

It is remarkable that patients in this disease occasionally complain of hunger, under the existence of the worst symptoms of the latter stages, and ask for food almost immediately before death. Mr. James Orton has noticed a case attended with the usual burning pain at the stomach, frequent pulse, hot skin, and spasms; and at the same time the patient complaining of being *very hungry*.

Dr. Taylor, in an interesting report to the Medical Board of Bombay, observes:—"In the numerous cases which have fallen under my observation, a variety of symptoms have presented themselves. Nothing indeed excites greater surprise, or perplexes the practitioner more, than the diversified symptoms of this disease. From the name of Cholera Morbus which has been given to it, we should have supposed that vomiting and purging, and especially of bile, were the invariable and most distressing symptoms. In a number of cases, however, there was neither vomiting nor purging; while in others there was vomiting without purging, or *vice versa;* but in none was there the smallest appearance of bile. Besides, when the vomiting and purging did occur, they were in the majority of instances by no means frequent or severe; and were in general easily checked by calomel and laudanum. * * * * The patients also frequently complained of

burning pain in the region of the liver. * * * * In some cases the throat was especially affected with spasms; though without any degree of pain, and the patient was rendered incapable of utterance. Trismus also occurred in several instances. Some individuals were seized with general tremors; while others complained of a sensation as if their bodies were pricked with pins." He proceeds to distinguish three different descriptions of the disease. The first and second differ from each other chiefly in rapidity and danger. The third is marked by the extreme suddenness and violence of the attack, producing perfect syncope. "The patients fall down suddenly deprived of sense; the pulse is often feeble and indistinct, but sometimes rather full and strong: when he recovers a little, he complains of great pain in the head and giddiness, and frequently of pain in the abdomen. Trismus occurred in two or three of these cases." It does not appear that cases of this kind are always the most dangerous. In the only one given in detail by Dr. T., the state of insensibility was quickly recovered from; the pulse was found to be good, though trismus was present, and it terminated favourably, apparently in consequence of bleeding*.

Sonnerat and Bartolomeo have mentioned this disease in their accounts of this country; and the brief details of its symptoms which they give may be added, as they exhibit the appearances which to common and casual, but unbiassed observation, have appeared the most remarkable. Sonnerat says it is marked by "a watery flux, vomiting, with extreme faintness, a burning thirst, an oppression of the breast, and a *suppression of urine.* Sometimes the diseased felt violent cholicky pains; often lost his speech and became deaf; pulse small and concentrated. The patient was frequently carried off in twenty-four hours." On one occasion he terms it, "an indigestion." This phrase expresses a remarkable

* Reports, p. 17.

symptom of the disease which I have omitted to notice. It would appear that the process of digestion ceases, even some time before the disease manifests itself; for nothing is more common than the food being thrown off on the first attack, perfectly unchanged, although many hours after it had been eaten.

Bartolomeo informs us that the disease is termed *Mordezym* by the natives; and that Sonnerat has transformed this phrase into *Mort de Chien*. He says it is characterized by "vomiting, *fever*, and *stupefaction*;" and was usually fatal in a few hours.

CHAP. II.

OF THE INFORMATION DERIVED FROM DISSECTION IN CHOLERA.

SECT. I.

APPEARANCES ON DISSECTION.

THE morbid appearances which I have observed on dissection, in a great number of instances, in this disease, have been pretty uniformly as follows:—

A dark blue or livid colour of the surface of the bodies; existing in various degrees in different parts and different subjects, and most remarkable at the extremities. It appeared to prevail most in the more robust and sanguineous subjects, and in the more rapid cases. Blood taken from both the venous and arterial systems was found to be of a very unusual dark and purplish colour.

The internal organs in general were found much gorged with blood. This was particularly remarked in the veins of the mesentery and stomach, and in the lungs.

The stomach exhibited many extensive patches of a crimson colour, usually confined, in a great measure, to its inner coats. Similar appearances existed in the intestines, most remarkable on their inner surface, but appearing externally in a greater degree than in the stomach; they were much more evident in the small than in the large intestines, and often occupied large portions, or the whole of the canal. The degree in which these appearances in both stomach and

intestines existed, seemed in general to bear some relation to the duration of the case, for in such as had been of several days' continuance they were highly marked.

The stomach contained the ingesta which had been given for some hours before death, in considerable quantity, and little altered either in appearance or smell. Calomel was frequently found at the bottom of the fluid contents, and adhering in various places to the mucous coat*. The intestines were in a great measure empty. Their contents were usually free from the slightest tinge of bile, and consisted chiefly of a dirty whitish mucus, resembling conjee or thick barley water, slightly tinged with milk. Great portions of them, particularly the large intestines, were frequently found contracted, so as with difficulty to admit the finger into their cavities.

The gall-bladder contained the natural quantity of bile, of no very remarkable appearance. The gall-ducts were found pervious, the bile flowing readily into the duodenum on pressure being made on the gall bladder. No unusual accumulation of bile existed in the ducts or their ramifications; but a small quantity of that fluid, of the healthy appearance, might be squeezed out of each of the pori biliarii.

The urinary bladder was almost invariably found contracted to the size of a hen's egg, without containing a drop of urine; but smeared internally with a whitish mucus, similar to that found in the intestines. The ureters contained the same substance.

The veins of the brain were much distended with black blood. The minute arteries of the membranes of the brain were frequently found injected. These appearances of vascular action were most marked in subjects who had died perfectly comatose or apoplectic, and like those of the stomach and intestines in protracted cases.

* I have been informed by a practitioner in whose observation I have great confidence, that he had frequently found this medicine adhering chiefly to those parts of the stomach which were inflamed.

Mr. Annesley, garrison surgeon at Madras, has examined the appearances on dissection in a great number of cases, with much industry and attention; and from the known abilities and experience of that gentleman, his observations must carry with them all the force of truth. In the case of a native, who was recovering from amputation, and died after a few hours' illness, the following are the principal morbid changes which he noticed after death:—

The small intestines in many places of a thickened pulpy appearance, and darkish pink or flesh colour, inflated with air, and bearing evident marks of great congestion; similar appearances of suffusion and congestion in the stomach; the colon contracted without congestion or change of colour.

The lungs were found collapsed and condensed, of a black colour on both sides, resembling a mass of bruised flesh, and when cut into, bled profusely. The heart containing black blood thoroughout.

The meningeal arteries and veins were exceedingly turgid, both in their trunks and branches. In the anterior portion of both hemispheres of the cerebrum there was the appearance of considerable arterial action, the arterial branches spread over that part of the brain being highly injected with red blood. The large veins in the same situation were likewise highly injected with black blood; and upon the middle lobe of each hemisphere, there was a kind of gelatinous extravasation, as if some severe injury had been inflicted. Six ounces of watery fluid were found between the membranes. Some effusion was also found in the cerebellic cavity, and in the top of the spine; and a very great turgescence of the vessels surrounding the whole of the cerebellum.

In the dissection of two Europeans, whose cases were of the usual kind, and pretty similar to the above, almost precisely the same appearances were found. The same gelatinous effusion on the membranes of the brain is distinctly described; the same dense, black, and congested appearance of the lungs is also particularly adverted to. In one of them

the duodenum and jejunum were found of light rose colour, the ilium of a darker red, and much contracted. About two feet of the latter was of a dark blue colour; and in general the vessels on its external coat beautifully injected. The whole of the large intestines, but particularly the rectum, of a dark red colour. Adhesions of the lungs to the pleura costalis were likewise found.

Another case, which was fatal in eighteen hours from the attack, exhibited appearances in general similar to the three former; but the whole of the internal coat of the stomach was of a dark bloody appearance, as if blood had been extravasated in considerable quantities between the coats. The brain and lungs as in former cases. In many succeeding dissections, the appearances were found so similar, that Mr. A. has deemed it unnecessary to particularize them: the above observations are, in general, referred to as expressive of the whole. The serous effusion on the brain does not, however, appear to have been generally observed in so great a degree as in the first case.

In a circular letter written by the Medical Board at Madras, on the first appearance of the epidemic on the establishment, giving a full and distinct account of the disease, with directions for its treatment, the morbid appearances on dissection recorded are: — inflammation and determination of blood to the stomach, intestines and other abdominal viscera, and even the brain itself; contracted state of the urinary bladder. In one case it is remarked that the stomach and intestines were inflamed, and their texture so much destroyed as to occasion their being lacerated by the slightest touch. The duodenum was remarkably hard and contracted.

Mr. James Orton has observed in some dissections which he has made, "the stomach much distended with flatus, and in one instance containing two quarts of watery fluid; considerably inflamed internally, very slightly externally. The small intestines had the rose colour usually observed, externally; internally much inflamed; and containing through their

whole length, except a hand's breadth or two from the stomach, a greyish mucus tinged with blood. The colon contained a similar matter; but it appeared as if its more fluid part had been absorbed, leaving it like small pieces of coagulated blood. This intestine was contracted and seldom inflamed. Parts of both the convex and concave surfaces of the liver, exhibited marks of inflammation. In one instance feculent matter was found in the stomach. In another its inflamed mucous coat was covered with opaque viscid matter, which appeared to be coagulable lymph. The vessels of the brain were turgid; and, on cutting into its substance, spots of blood appeared on the divided surfaces." He adds: "These dissections prove, in a very striking manner, the rapidity with which inflammation of the stomach and intestines is produced; for all the appearances above described must have been formed in the course of twelve or fifteen hours."

Mr. Kelly, in the report of a dissection sent to the Medical Board of Madras, observes: — "The left lobe of the lungs was much inflamed, with strong recent adhesions, extending to the mediastinum and right lobe. The omentum and stomach were also a good deal inflamed, particularly the inner surface of the latter, which was covered with viscid mucus of a dirty white colour, and had some appearances of extravasation. The small intestines more or less inflamed; particularly the ilium, which was smeared internally with a bloody mucus. The colon and rectum also inflamed." In another case the appearances in general were similar; and in this instance it is remarked that the pulse had risen, and the heat of the body returned, with delirium, some hours before death. It does not appear that the brain was examined.

The Medical Board of Bengal have observed appearances very similar to those already described: — Excessive congestion in the internal veins; inflammation and effusion of coagulable lymph on the brain, and adhesion between its membranes *. They observe that "the abdomen, upon being

* See their letter in the Appendix.

laid open, emitted a peculiar offensive odour, wholly different from the usual smell of dead bodies; and it was believed, perhaps rather fancifully, that the bodies sooner underwent putrefaction than those of persons dying under the ordinary circumstances of mortality." I have reason to believe that this remark is not unfounded; for I have observed putrefaction come on in several of these instances with great rapidity. In the last fatal case of the disease which I have witnessed, I was prevented from making a post mortem examination by interment having taken place about eight hours after death, in consequence, as I was informed, of the offensive state which the body was in. The weather at the time was moist, but not hot.

Mr. Whyte relates the case of a native who died after thirty-six hours' illness. On dissection the stomach was found completely distended with an immense quantity of half digested rice and meat, which was supposed to have been given clandestinely not long before death. On the convex surface of the liver a considerable extravasation of blood was found. The lungs were much collapsed. The usual morbid appearance of the vessels and coats of the stomach and intestines occurred. The large intestines contained the usual white matter; but the contents of the small intestines were tinged with black bile *. In this case it is evident that the secretion of bile had returned. It also shows the torpid state of the stomach which takes place in the latter stages; and affords an instance of another remarkable symptom which has already been noticed — the desire for food shortly before death.

Dr. Burrell found "the liver of a dark colour, distended with blood, and the gall-bladder full of bile; the spleen of an extremely blue colour; the omentum inflamed, and its veins filled in every part; the small arteries of the intestines of a lively red; the colon contracted throughout its length

* Reports, p. 65.

to the size of the middle finger, and its calibre was so small as hardly to allow a scalpel handle to be introduced.

"The veins of the stomach more particularly arrested our attention; on the great curvature they were of an intermediate size between a crow's and a common quill; these turgid veins were more apparent internally; and the most forcible injection could not have more completely filled the vessels. The mesenteric vessels, as well as the vessels of every other internal membrane, partook of this appearance of increased action. The lungs were dark and suffused with blood. This most probably is the cause of the stertorous and laboured breathing present in almost every fatal case *."

Mr. Whyte, in a case of nineteen hours' duration, observed "the liver increased in size, and full of blood. The vesica fellis pretty full; the stomach very much so, and of so dark a colour, that on a superficial examination it might be thought in a state of gangrene. The small intestines too presented a similar appearance, and might easily give rise to a similar mistake; but both were perfectly adhesive and firm. The colon was contracted to the thickness of a finger, and pale." He considers the dark appearance of the stomach and intestines as arising from fulness of their small veins; and describes the extreme turgescence of the larger veins noticed by Dr. Burrell. The lungs were found of a much darker colour than natural, approaching to that of the liver; the bladder empty; and he adds, "indeed all the secretions seem almost wholly suppressed in this disease, except those of the stomach and intestines, which are much altered in quality."

In another case of thirty-eight hours' duration, which was comatose for twenty-four hours before death, the same dark colour of the stomach was found, but without distension of the larger veins. "A portion of the ilium, to the extent of about eighteen inches from the *cæcum caput*, with its corresponding mesentery, was perfectly black and gangrenous in

* Reports, p. 69.

appearance. We pronounced them so at the time, but upon reflection I think the gut possessed too much tenacity of texture; and this appearance might be given by extravasation, which I believe is difficult to be distinguished at all times from the former state. The colon throughout was much more diseased than either the stomach or upper portion of the small intestines, although not so much so as the portion of the ilium just taken notice of. It appeared in a state intermediate between venous congestion and arterial inflammation; indeed its colour and whole appearance, as well as that of the mesocolon, was of that mixed nature, that I do not know a better method or mode of expression, whereby to convey an idea of it. And here I may remark, that in this disease I think the former state runs frequently into the latter.

"On examining the upper part of the cranium we thought the dura matter inflamed; the trunks of large blood vessels were distinctly seen through it; and on removing this membrane we were presented with a beautiful sight; the veins of the pia mater distended as if ready to burst, and running in all directions among the convolutions of the upper hemisphere. The increase of size was perfectly sufficient to account for the coma which had taken place. Several small arteries were seen, but I think not more than are usually found; and certainly not enough for us to infer that the membrane had been inflamed. No serum was found in the ventricles *."

It appears to me sufficiently evident, that the dark blue or black colour of the stomach and intestines in these cases was owing to actual gangrene. That their firmness was not much destroyed, is by no means sufficient to disprove this conclusion; for in enteritis and dysentery similar appearances are found, without destruction of texture, in their slighter degrees. It is difficult or impossible to conceive that they could be produced by simple congestion; and they were observed in even a greater degree in the second case, in

* Reports, p. 73, 76.

which the turgid state of the veins of the abdominal viscera was not found. The existence of inflammation in these organs was also evident and admitted.

Mr. Craw, in a case of eighteen hours' duration, found on dissection, "the vessels of the stomach, duodenum, and the whole of the alimentary canal, with those of the mesentery, liver, and lungs, amazingly gorged and distended with blood. Many of the veins, particularly of the stomach and mesentery, were as large as crow-quills; and the smaller ramifications of the arteries were also distended; with every appearance of general inflammation as well as venous congestion. The arch of the colon was much contracted."

In another case "symptoms of coma and great derangement of the head, with great anxiety and oppressed and laborious breathing, speedily came on; and the hands, arms, and lower extremities were cold, while the rest of the body retained its natural temperature. Powerful stimuli were administered, and blisters applied to the epigastrium, head, and back of the neck, and leeches to the forehead; but these were not successful in drawing blood, and the man sunk. On dissection we found the same congestion of blood in the abdominal and thoracic viscera as in the former case; but there were also large spots of extravasated blood found in different parts of the intestinal canal; and in other places decided appearances of increased arterial action; while a large portion of the ilium and colon was in a completely gangrenous state. I felt certain from the symptoms that the brain would indicate disease; and nothing could be more convincing than the appearances when the calvarium was removed. The most expert anatomist could not have injected the ten-millionth part of the vessels which covered the membranes, and the surface of the brain. It appeared, indeed, as if the whole was nothing but a mass of blood vessels; and every little branch seemed so entirely distended and glutted, as if one drop more must have ruptured it. There was no effusion of fluid on the surface, nor in the ventricles. In the space of twenty

or thirty hours, therefore, you see there is not only formed a true congestive disease, but inflammation, and even gangrene have taken place." He adds, that these comatose patients invariably die.

Mr. Gordon observes: — "It appears to me that the epidemic, now prevalent here, generally attacks in the first place the brain, and that the stomach is, in most cases, only secondarily affected. This I consider the nature of the disease in general; although there certainly are cases in which the stomach is principally and primarily concerned; but, even when this is the case, I think we have chiefly to dread acute inflammation of that viscus, and not the continuance of vomiting and purging." These views are illustrated by a review of the symptoms and appearances on dissection, which he describes as similar to those already detailed.

In the valuable work from which these extracts are taken, many other accounts of appearances on dissection are given, but they are so similar to those already described that it is unnecessary to detail them. I have also consulted many dissections recorded by the medical officers of this establishment, and obtained similar results. Marks of inflammation in the liver are, likewise, not unfrequently noticed. In several instances the same appearances were found in the heart and lungs. I have been informed also, that actual extravasation of blood in considerable quantities has in some instances been found on the surface of the brain. The facts that I have stated, regarding the appearances of inflammation bearing some proportion to the duration of the case, I have often found confirmed in the course of these inquiries.

SECT. II.

INFERENCES FROM THE APPEARANCES ON DISSECTION, AND GENERAL OBSERVATIONS.

The information derived from the preceding observations is evidently of the most important and valuable nature. They uniformly show, that a high degree of venous congestion prevailed in the internal organs in general; and they no less distinctly prove the existence of that universal tendency to inflammation, which has already been frequently adverted to.

The dark colour of the surface of the bodies and of the blood, clearly show a great deficiency of the change which that fluid undergoes in the lungs; and this inference is supported by the appearance of the blood drawn during life, which has constantly been observed to be of a very dark colour. From the multitude of evidence which might be adduced in proof of this fact, I will select only that of Mr. Scarman; whose experience at the head of the medical department of the Field Force in the Dooab, together with a professional industry very rarely equalled, entitle his observations to the highest degree of credit. He observes, in an official report: "In bleeding in this disease, it has been remarked by every one that the blood is of an unusually dark colour, and that in proportion to the progress of the disorder: and that it coagulates less firmly than in health. The white coagula found in the heart, and also in the extremities of the veins terminating in the auricles, indicate that the blood coagulates slowly after death; but the blood taken away in the treatment of the disease coagulates in the usual time, and does not deposit its red particles; but in many cases the serum separates from the coagulum more slowly than usual." I have to regret that I have not particularly attended to the coagulation of the blood; if it is constantly

found to take place less quickly or firmly than usual, the fact will be highly important. In one instance, however, I have witnessed the remarkable circumstance of its not coagulating at all. The blood as it flowed from the arm, on this occasion, was of a very dark colour; and on inspecting it about four hours afterwards, it was found perfectly fluid, with a portion of serum about half an inch in depth, and nearly as white as milk, floating at the surface. The case was of a very severe nature, and terminated fatally from the secondary consequences of the disease.

The presence of the ingesta in large quantities in the stomach, during a disease which is marked in its earlier stages by excessive irritability of that organ, together with a total cessation of vomiting for some hours before death, and the unchanged nature of the contents of the stomach, afford strong presumptions that that organ had entirely lost its capability of action, if we except that of inflammation; and, consequently, that the process of assimilation had ceased for some time previous to the fatal event. Indeed, so strong did these and other appearances lead to such conclusions, that it was the unanimous opinion of the superintending surgeon and two other medical officers at Bellary, besides myself (in conjunction with whom a great number of the foregoing observations were made), that the whole alimentary canal had become *paralysed*, and entirely lost its natural motion and powers, for some time before death. Under these circumstances, we need no longer be surprised and disappointed that the most powerful stimulants should fail in restoring the sinking powers of life throughout the frame; for it is probable that all our remedies, in the latter stages, remain inactive in the primæ viæ. That inflammation should prevail in these states of the system is truly surprising; but it appears to be an established fact, that it goes on with extreme activity notwithstanding these circumstances; indeed, as far as we can perceive, in consequence of them. It is highly worthy of inquiry, whether the sudden sinking of the vis vitæ,

in other diseases as well as in cholera, is attended by this extreme tendency to inflammation?

The observations on the biliary and urinary organs after death, confirm the conclusion, which, indeed, was sufficiently evident from the symptoms during life, that not only the evacuation, but the secretion of both bile and urine, are completely suppressed in the worst forms of the disease. The suppression of bile, and its relation to the violence and danger of the disease, have long been observed in Indian cholera; and, since the extensive prevalence of the epidemic, the important fact has been ascertained, that the secretion of urine is similarly affected in similar states of the system. Struck with this perfect and obvious analogy, and the generalization which it appeared to authorize, I have been led to pay particular attention to the latter of these symptoms, in order fully to ascertain its existence; and I have invariably found, that the secretion of urine was completely suppressed under the existence of the more violent symptoms and dangerous states; and that the remarkable appearance of the urinary bladder, described above, was constantly met with on dissection, in the unmixed forms of the disease. I was first led to this inquiry by analogy suggesting the probability of the secretion of urine being similarly affected with that of bile; but I soon found that the fact was no original discovery, for it had been previously in many instances observed.

From this agreement in two of the principal secretions, we are naturally led to expect similar affections of the others; and accordingly they are found in a very remarkable degree. The healthy secretions of the intestines are evidently suppressed throughout the disease; for their discharges possess neither the appearance nor the smell of feces. The watery secretions of the stomach and intestines appear in excess previous to their suppression; but in this they only resemble that of bile, with this difference, that they require a greater degree of disease for their suppression. The bile appears in

excess only in the milder cases; the intestinal serum is excessive in the earlier stages of the more severe as well as the milder cases; but they appear still to be both subject to the same general law of *excess from the slighter, and suppression from the greater degree of disease;* for in all cases which terminate fatally, the purging becomes suppressed as the disease arises to its maximum; and in the most rapid and fatal cases it is slight, and quickly ceases, or does not occur at all.

I have frequently observed patients in this disease making great complaints of dryness of the mouth; and the extreme, and as they have termed it, *choking* thirst, which invariably attends, is probably occasioned, in some degree, by the deficiency of saliva.

In the latter stages the eye assumes a dull and glassy appearance, and is occasionally covered with a film. These circumstances appear to prove a deficiency of the secretion of tears, which in health is continually poured out over that organ.

The secretion of the skin, like that of the intestines, appears in great excess; and this occurrence is most remarkable in the early stages, when vomiting, spasms, and other marks of increased action are present. It is probable that it will be found, like the other secretions, to become entirely suppressed before death; but this I have not distinctly observed. I have however remarked (and a similar observation has been made by others), that blisters constantly fail in producing any discharge in the worst stages. I have several times seen them produce inflammation and redness, even greater than usual, causing the cuticle to be thrown off, but without any discharge, either serous or purulent.

Such is the detail and the course of the phenomena of cholera, both in the living and dead subject, as far as my experience

and researches have enabled me to become acquainted with them. It is fully sufficient to confirm the position with which I set out—that they are "extremely numerous, important, and peculiar." I trust it will also be found sufficient to inspire my readers in Europe with some portion of the deep interest which this unparalleled affection has excited in India; and which I have felt to be such as in great measure to absorb every other sensation and pursuit, since I first met with the disease.

CHAP. III.

OF THE PROXIMATE CAUSE OF CHOLERA.

THE proximate causes of diseases in general have been said, almost proverbially, to be covered with the deepest obscurity. They are involved in the primary movements of the animal economy; and, until physiology shall have made us more intimately acquainted with the nature and causation of these movements, all inquiries into the essential nature of disease must remain, as they have always been, in a great measure vague and hypothetical. As we possess but a very imperfect knowledge of the states of the moving powers which produce health and all its phenomena, it is not surprising that we should be unable to discover what are the changes in them which give rise to the phenomena of disease; and, when we venture to substitute hypothesis for fact, that our conclusions should frequently be wide from the truth. Hence unfounded theories of diseases have continually been formed, and have misled their credulous followers; but in the present enlightened state of the world, and with the cautious, and even sceptical modes of reasoning now in use, it is probable that a false hypothesis cannot gain or maintain credit: any attempt to classify and explain on general principles the phenomena of a disease cannot, therefore, be injurious to science, and if founded on truth, must be beneficial. The want of a sufficient number of *data* is the great obstacle to the solution of every difficult problem; and this is particularly experienced in questions of pathology; but in cholera we are presented

with a greater number of striking general facts, from which fixed principles may be deduced, than any other disease seems capable of affording.

The uncertainty and imperfect nature of the science of medicine rarely admit of direct reasoning from fundamental principles, or of mathematical precision; and consequently *analogy* is almost the only method which is left of extending its attainments. But by this means the most important discoveries have been made. The analogy between small-pox and cow-pox appears to have led JENNER to the discovery which has immortalized his name. The obscure similitude which Sir Isaac Newton perceived between the diamond and other combustible bodies induced him to believe that it might be burned; a supposition which was verified by experiment, and gave rise to the discovery of its composition. In the same manner it is probable that the resemblance between cholera and other diseases and affections, of which we have more knowledge, will throw a light upon its nature.

On a general review of the morbid affections of cholera, the circumstance which most strikes us is their prevalence throughout every department and organ of the animal economy. In other diseases we generally find some organ, or, at least, some class of organs, preeminently affected, whilst the rest enjoy a comparative immunity from disease; but on a sudden and violent attack of cholera, the brain, the heart, the lungs, the stomach and intestines, the liver, the kidneys, the muscles of voluntary motion, and organs of sense, appear to be almost simultaneously and equally affected; and almost as many and various are the "seats of the disease," in which it has been seated by different speculators*. It is evident,

* The liver has an ancient and hereditary title to this supremacy, from which all the force of Indian evidence will probably be unable entirely to depose it. Many persons in this country have agreed that the affection of the stomach and intestines was the first link of the chain of morbid action; but then came the questions, which of them was to take precedence of the other, and what was the nature of their

therefore, that no cause but one of the most general agency throughout the frame is sufficient to account for these occurrences: and to fix on any disturbance or suppression of a function which is not *immediately* necessary to life (as those of the liver, the skin, or even the stomach), as a primary affection, and to suppose that it affected the others by sympathy — a mode of action which we do not even pretend to understand — or in any other manner, would be an hypothesis, not only unsupported by any sufficient arguments, but contradicted by facts. The sudden defection of all the powers of life, which is far the most prominent and urgent of the phenomena of the disease, strongly argues a failure in the sources from whence the vital actions are immediately derived.

The ingenious researches of Mr. Brodie*, concerning the agency of the NERVOUS SYSTEM in the animal economy, and their important results, are well known. In some experiments he maintained the circulation in animals, by artificial respiration, for a length of time after the head was removed, or the spinal marrow divided; and gave rise to a series of phenomena which bear a considerable analogy to cholera.

1. It is a familiar fact, that the removal of the influence of the brain from the rest of the system, either by taking off the head or dividing the spinal marrow, produces spasms and convulsions of the muscles; and it appears that these occur-

affection, whether vascular or nervous; or, as one authority on the subject maintains, neither, but a new mode of action, sui generis, which formed the *fons et origo mali*. Another authority asserts, that the disorder is seated in the brain, and actually consists of *concussion* of that organ. A third and most respectable authority holds, that the heart is pre-eminently affected, and terms the disease *cholera asphyxia*; others, seeing the dark colour of the blood, and the oppressed respiration, with great plausibility infer that the lungs are primarily affected. Another conceives the disease to consist of spasm in the capillaries of the whole system.

* Edin. Med. and Surg. Journal, October 1812.

rences were more remarkable in Mr. Brodie's experiments than under ordinary circumstances. Here then we find this similitude of affection between the decapitated animal and the human subject in cholera, that the muscles of both are thrown into spasm.

2. In the subject of experiment the generation of animal heat is found to cease, on the connection with the brain being cut off, notwithstanding that the respiration and circulation continue, and the usual changes of the blood take place. In cholera the temperature of the body is remarkably diminished, and in some cases it sinks so rapidly that the generation of heat appears to have completely ceased.

3. In the animal, the secretion of urine ceased on the removal of the brain; and it is presumed from analogy that the other secretions were similarly affected. In cholera the secretions are suppressed.

From these and similar experiments it is inferred, that secretion and the evolution of animal heat depend upon nervous influence, and consequently that they cease when that power is removed.

It may be alleged, that any reasoning founded on the appearances presented by an animal possessing scarcely any other property of life than respiration and circulation, cannot with precision be applied to the living system in disease; and I will allow that further proofs are required to corroborate it, before any accurate inferences can be drawn. Such, however, I trust, are not wanting.

It has been the opinion of our most eminent physiologists, that the depressing passions are sedative powers, which produce their effects by diminishing the energy of the brain; and accordingly we find them producing many symptoms perfectly similar to those of cholera. Depression of spirits and despondency are amongst the earliest and most constant symptoms of that disease; and the anxiety and restlessness which characterize it, bear the strongest resemblance to the effects of excessive grief. That passion also produces the same ex-

treme weakness of the circulation, debility and tendency to spasm in the muscles, sinking of the countenance, and coldness of the body, as are so remarkable in cholera. Grief and fear likewise give rise to many local effects bearing the same resemblance—headach, nausea, colic, diarrhœa, cold sweats, and pale urine. A classic author has given a description of the effects of excessive terror, which perfectly corresponds to the first phenomena of the most sudden and severe attacks of cholera.

> Verum, ubi magis est vehementi metu commota mens,
> Consentire animam totam per membra videmus:
> *Sudoresque ita, palloremque existere toto*
> *Corpore; et infringi linguam, vocemque aboriri,*
> *Caligare oculos, sonere aures, succidere artus.*
>
> LUCRETIUS.

It has long been a prevailing opinion that fever is produced, either directly or indirectly, by an affection of the nervous system; a theory which appears to have been first proposed by Hoffman: that of Boerhaave, though grounded on a far different principle, admits that *a sluggishness of the nervous fluid* combines with a viscidity of the arterial blood to produce it. His commentator, Van Swieten, infers, that both *deficiency* and inactivity of the nervous fluid are the principal causes of fever. Huxham observes, that "contagion seems to affect not only the blood, but *primarily also the animal spirits.* I think the sudden damp, weakness, tremblings, and great dejection of spirits at the very attack, evidently prove it."

Tode attributes fever to irritation of the brain: and Cullen expressly maintains, that *a diminution of the energy of the brain directly produces the phenomena of the cold stage,* and indirectly those of the hot stage. Much of these doctrines has, indeed, been expelled from the schools of medicine; but it is still an established position, that the cold stage of intermittent fever is owing to diminished energy of the brain, or nervous system: and in that affection we find

nearly the whole of the principal symptoms of cholera, in a minor degree, and scarcely any other:—the coldness of the body, and the blue and shrunk surface—the weak pulse, debility, restless anxiety and apprehension—the stupor—the nausea and vomiting—the suppression of secretions; as is apparent from the thirst and deficiency of saliva, the scanty and insipid urine, and from the drying up of ulcers—the diminished sensibility—and, lastly, the spasmodic state of the muscles, evinced by the rigors, which frequently arise to the extent of perfect convulsion. It is impossible to account for so great a similarity of effect without supposing a similarity of proximate cause.

The conclusion to which these views, and others which shall subsequently be unfolded, appear to me irresistibly to lead, are the following:—

1. *That the proximate cause of cholera consists in a diminution of the energy of the nervous system.*

2. *That the deprivation of nervous influence thus produced, extends in various degrees to all the functions; and immediately produces the phenomena of the disease*.*

On this hypothesis the numerous and various symptoms of cholera admit of as perfect an explanation as any of the most simple and familiar morbid affections of the animal frame have obtained.

The human mind is incapable of admitting with precision more than one idea at a time; much less has it the power of comprehending at one view the causation of the complicated and contradictory symptoms of cholera. To accomplish this it will therefore be necessary to examine each of them separately, and to endeavour to trace it to its origin. But as

* It is unnecessary to enter into the question of the propriety of the term *proximate cause*, or the sense in which it should be employed; suffice it to say, that it here expresses the essence of the disease, and the immediate origin of its symptoms; that they are, with perhaps a few exceptions, produced immediately from *one* cause, will subsequently be attempted to be proved.

many of them bear a perfect analogy to each other, and have the same situation, it will be useful to class them according to these affinities, and to consider them, in the first instance, in a more collective form.

The following arrangement, though not strictly founded on any of the great physiological divisions of functions, will probably be found to produce the arguments and inferences which I have to bring forward in the most eligible order.

1. The affections of the Muscular Systems, both voluntary and involuntary, exclusive of the organs of circulation.
2. The affections of the Secretions.
3. The affections of the Senses.
4. The affections of the Circulating System.
5. The affections of Respiration and the Changes of the Blood.

CHAP. IV.

ANALYSIS OF THE SYMPTOMS OF CHOLERA.

SECT. I.

OF THE AFFECTIONS OF THE MUSCLES.

1. *Of the Spasmodic Affections.*

THE proximate cause of muscular contraction is one of the great arcana of physiology, which have eluded all inquiry, and the hypotheses which have been framed to explain it, have obtained no higher rank than conjectures. It has been imagined, that the phenomenon is produced by the influx of a portion of the nervous fluid, directed into the muscle by the energy of the brain. Agreeably to this theory, we should attribute the violent spasmodic action of the muscles which we meet with in disease, to increased energy of the brain; but if we examine the circumstances under which spasm usually appears, we shall find them indicating the very opposite state of that organ. Thus, if we bleed a patient in the recumbent posture until a degree of faintness comes on, and then suddenly raise him upright, syncope will be produced. The brain will cease to perform its functions of sensation and volition from being deprived of blood; and at the same time spasmodic action of the voluntary muscles will take place. The insensibility is evidently owing to the functions of the brain being suppressed; and it is not less clear that the convulsions have the same cause. Hence we should infer, that *deprivation of nervous influence produces spasm.*

The instances which may be adduced in support of this position are very numerous. The convulsions which invariably ensue on taking off the head, or dividing the spinal marrow of a living animal, are the immediate consequences of cutting off the great source of nervous influence; and are perfectly incompatible with the supposition that spasm is produced by any irregular exertion of the energy of the brain. It may be conjectured that they are owing to the *irritation* produced by cutting the spinal marrow; but Portal has found that the same effect was produced by compressing it*.

Dr. Yelloly, in the first volume of the Medico-Chirurgical Transactions, gives an account of an experiment in which the right half of the spinal marrow of a dog was divided at the first vertebra. Immediately after the division the animal seemed dead and *stiff*. It was found that the extremities of the left side were more stiff than those of the right, and that on bending them they immediately returned to their former position, and remained stretched out. The extremities of the right side, on the other hand, were more flaccid, and retained any position in which they were put. The tail, at the basis, was drawn to the left side. The stiffness of the extremities in this instance is a perfect proof of the existence of the tonic spasm; and it is no less evident that it was produced by deprivation of nervous influence.

That "atony is the parent of spasm," is an axiom in medicine; and it is scarcely less evident that atony itself is a consequence of diminished energy of the nervous system, or portions of it; for its chief characteristics are the diminution or cessation of those actions of health which depend upon nervous energy.

It appears to be established, that the depressing passions produce their effects by diminishing the action of the brain. Hence we may infer, that the start produced by sudden terror, and the tremor which succeeds, the violent action of

* Edinburgh Medical and Surgical Journal for January, 1818.

the muscles of respiration in sighing and sobbing, and those of the face in weeping, are spasmodic affections arising from deprivation of nervous influence. And when these exciting causes are sufficiently powerful, and acting on systems possessed of little nervous energy, or a great degree of *mobility* of it, it would appear that power is so far exhausted as to produce the diseases which instantly follow; — hysteria, epilepsy or apoplexy, palpitation of the heart, or syncope. In all these affections spasm is a prominent symptom, and they are all attended with insensibility, or other symptoms indicating the diminution or cessation of the functions of the brain.

Dr. Cullen informs us, that a large proportion of the causes of epilepsy produce the disease by diminishing the energy of the brain; and it is probable that the operation of the whole of them may be traced to the operation of the same principle. Spirituous liquors are said to produce that disease immediately by their *stimulating* powers; but it is usually not until their stimulation has ceased that the paroxysm appears. A soldier, predisposed to epilepsy, shall keep himself in a continual state of intoxication for a week, without any bad effect arising, so long as he keeps up the stimulus; but when he has expended his "balance," and is obliged to leave off his potations, and when tremor, debility, depression of spirits, and other symptoms of diminished energy of the nervous system appear, the disease will make its attack. Hence also it appears to be, that intemperance is the grand predisposing cause of tetanus; and that it produces more attacks of cholera in Europeans than all the rest of its exciting causes together — an assertion which, from my own experience, I can confidently make.

It has been presumed that a diminution of the energy of the brain tends to produce spasm; if this proposition be true, its converse should also hold good—the natural energy of the brain should produce dilatation, or prevent spasmodic contraction. Many facts appear to yield this confirmation of the theory. "In the muscles of living animals treated with stimuli, the

contraction is often not so vigorous, nor so strongly marked, as just after death; sometimes, indeed, during life, irritation produces no contraction. The nervous influence interferes with and disturbs the contraction. By dividing the nerves of a part this power is entirely got rid of*."

Fowler has found that "frogs, in a healthy state, were rarely acted on by galvanism; but as soon as the sciatic nerves had been divided, and the influence of the will on the movements of the extremities suspended, the contractions produced by galvanism were as powerful as if the legs had been entirely separated. Even when the metal was brought in contact with the denuded nerve, the contraction did not ensue unless the nerve had been previously divided†."

These effects have been attributed to the power of volition preventing the contractions; but we have no evidence that this power is exerted, with regard to the muscles, when they are at rest; on the contrary, the most obvious conclusion is, that the influence of volition on the muscles is suspended when they are quiescent. The effort of the will appears to tend only to *produce* contraction. No exertion of the mind can directly prevent the occurrence of cramp in the fingers when it is felt coming on, nor produce the dilatation of the muscles when the contraction has actually taken place.

The preceding observations all tend to prove, that diminished energy of the brain may produce spasm in the muscles which are immediately dependent upon the brain; and therefore, that the spasmodic affections of the animal functions in cholera may be attributed to that cause.

The *tremor* of cholera is a spasmodic affection, and may consequently be referred to the same general principle. It is also indicative of want of due command of the muscles, which shows an imperfect performance of the functions of the brain.

Tremor has obtained, in common language, the appellation

* Rees's Cyclopedia, article *Muscle*.

† Wilkinson's Elements of Galvanism, vol. i, p. 143.

of *weakness of the nerves*, and it is probable that science cannot apply to it a more correct term. Dr. Darwin has referred it to deficiency of sensorial power. "A certain quantity of stimulus, less than natural, induces the moving organ into feebler and more frequent contractions. The spirit of animation derived at each interval into the acting fibres being less, these intervals likewise become shorter. Hence the tremors of the hands in persons accustomed to vinous spirits, until they have taken their usual stimulus*." Is not the common expression of *strength of nerves* equally correct? For what is the state which is opposite to tremor,—that perfect and almost indestructible command of the muscles, and that entire absence of all tendency to irregular or involuntary contraction, which may be termed *physical courage;* —what are all these but the effects of a high degree of energy of the brain, and nerves of voluntary motion?

The explanation which the foregoing views afford of the spasms of the voluntary muscles in cholera will probably not be admitted to apply to those of the muscles of organic life, as these organs are generally believed to be "independent of, but influenced by the brain;" for they derive their nervous influence from the system of the great sympathetic nerve, which is connected with that of the brain only by branches of communication. But the internal structure of the voluntary muscles is the same with that of the involuntary; their functions are the same, contraction and dilatation; and both are abundantly supplied with nerves, which are equally necessary to the action of the former as of the latter. And when we perceive similar affections arising at the same instant in both (as happens in the stomach and intestines and voluntary muscles in cholera), we cannot but conclude that they have similar proximate causes.

The sympathetic nerve is furnished with a great number of ganglia, or centres of nervous energy, which have received

* Zoonomia, vol. i, p. 122.

the appellation of "little brains;" and whose action is supposed to be analogous to that of the brain. Hence it is probable that the original cause which diminishes the energy of the brain will also diminish that of the great sympathetic nerve, and in fact every part of the nervous system; for the action of every portion of its medullary and cineritious matters is probably analogous to that of the brain itself*.

These views are indeed hypothetical, but we have much evidence of a most intimate connection and sympathy between the nervous systems of animal and organic life, for we scarcely ever find one of them affected with disease without the other: digestion is rarely performed with vigour, or the circulation undisturbed, in disorders of the brain and animal functions; nor can the strength of the limbs and other voluntary powers continue in perfection when those of organic life are depressed. In cholera these two systems appear to suffer almost equally; and this coincidence extends not only to the degree, but to the kind and the times of their affections: the stomach and intestines are frequently attacked with violent spasms at the same instant with the gastrocnemii muscles; the vomiting and purging generally cease at the same time with the muscular spasms. On a violent attack of the disease, both the brain and heart nearly cease to perform their functions in an instant.

On these principles we may account for the vomiting, the acute intermitting pain of the intestines, indicating the tonic spasm, and their increased peristaltic motion, which may be inferred from the frequent calls to stool, and the complaints

* "Many anatomists have considered the ganglia as little brains, and as so many separate origins of the great sympathetic nerve. Bichat has entered more at large on the same subject; and has established the ganglions as so many nervous centres, possessing each a separate action or influence, exerted on the nervous filaments passing from them to different parts. But they do not act in an insulated manner, for nervous filaments connect the cerebral and sympathetic systems, occasioning reciprocal influence."—Rees's Cyclopedia, art. Nervous System.

which are occasionally made of the bowels "feeling as if they were rolling about, or tearing out."

In colic and diarrhœa we meet with all these symptoms; and these diseases are known occasionally to arise from diminution of the nervous energy, as when they are produced by the depressing passions, and by lead, which, like most other poisons, is believed to act immediately on the nervous system. Concussion of the brain, which in an instant reduces the nervous energy, and consequently all the powers of life, to the verge of existence, produces also vomiting. If we bleed largely in the recumbent posture, and then suddenly raise the patient upright, the brain is at once deprived of the principal portion of its blood, its energies are diminished, nausea and vomiting are produced, and if there is tendency to purging (as in dysenteric cases) a call to evacuate the bowels certainly takes place. The patient probably staggers to the close-stool, his limbs are slightly convulsed, and at length he becomes insensible. Thus it is clear, almost to demonstration, that nausea and vomiting, purging, spasm, and extinction of the senses, those prominent features of cholera, are produced, at least in this instance, by diminution of the energy of the brain.

Nausea appears to be the extreme of *anorexia*, or to indicate the state of the stomach which is opposite to that marked by hunger, or the active process of digestion; for we know that nausea and desire for food cannot exist at the same time; and that if food is taken when the former symptom is present, it is not digested whilst it remains. If then, as we are taught to believe, hunger and active digestion are symptoms of abundant nervous energy in the stomach, it follows that nausea and vomiting should indicate the want of it in that organ. To this reasoning it may be objected, that hunger occasionally occurs in the acute stages of cholera; but this deviation from the ordinary course of nature cannot be considered as subversive of a rule so obvious as that which has just been drawn. We cannot for an instant suppose that the

symptom, in this instance, indicates that the stomach is in a fit state for digestion.

Dr. Darwin observes, "the action of vomiting as well as the disagreeable sensation of sickness, are shown to be occasioned by defect of sensorial power*." And this proposition receives the fullest proof from the simple fact of vomiting being produced by the division of the nerves which proceed to the stomach. Dr. Wilson Philip states, that he finds also dyspnœa (another of the symptoms of cholera) constantly produced by dividing the eighth pair of nerves.

The natural action of the organic muscles is believed to be produced by the stimulus of their contents, as the food, blood, &c., acting on their vis insita, or principle of irritability; the latter of itself being incapable of motion. In cholera we find spasm and excessive secretion occurring in the stomach and intestines, without the presence of any unusually irritating substances in those organs; but, on the contrary, when one of their stimuli, the bile, is absent. It is evident, then, that some other power must act on the irritability to produce the effect; and we cannot conceive that this exists anywhere but in the nerves.

There is another curious affection in cholera which may be referred to the head of spasm; the contracted state of the urinary bladder, which is found on dissection. It appears to be an exertion of the *tonic power;* or that action by which a divided muscle spontaneously shortens itself, and the limbs become stiffened after death. Is this contraction of the bladder produced by the general disposition of the system to spasmodic action, or is it merely a consequence of the long emptiness of that organ? The latter opinion has much weight; for in cases of intus-susceptio, the part of the canal *below* the obstruction, which is in an empty state, is found to assume the form of a solid cord; and in fact, this appearance of the intestines is common in cholera; and probably arises

* Zoonomia, vol. iv, p. 413.

from their emptiness, their contents having been carried off by the excessive action, and their secretions having ceased. In consequence of this state, the tonic power, or contractility of tissue of Bichat, is exerted, by which the organic muscles are supposed to have the power of adapting the size of their cavities to the quantity of their contents; whence these appearances may be produced.

2. *Of the Paralytic Affections.*

Partial paralysis of the muscles of the extremities cannot be reckoned among the common symptoms of cholera (as in colica pictonum); though it has been observed as a consequence of the disease, in some instances. But the fixed eye and dilated immoveable pupil, and probably also the eyelid incapable of closing, which have been so constantly remarked, are instances of paralysis in the muscles of the eye; the limbs are occasionally observed to be incapable of motion before sensibility disappears; in the last stages the stupor is frequently observed to arise to the extent of perfect apoplexy, consequently a total paralysis of the voluntary muscles occurs. The atony of the stomach and intestines, which takes place in the highest degrees of the disease, has also seemed to competent observers to amount to perfect paralysis. Hence it appears that this class of affections is scarcely less numerous and general than the preceding.

It appears paradoxical that the same cause should produce the opposite states of spasm and paralysis, but we must admit the fact. The following observations tend to prove that it is the partial or smaller deprivation of nervous influence in an organ which produces spasm; and the greater, or total extinction of it, which causes paralysis.

The principal character of apoplexy is paralysis, but it is also very commonly attended with spasm, and both are frequently present in the same case. One side of the body is found completely paralytic, whilst the other, which retains

sense and the power of voluntary motion, is affected with spasm*. Morgagni† relates several cases of this kind; and finds, on dissection, the injury of the brain on the same side as the spasm. In one of them, which was paralytic on the left side, and affected with spasm on the right, two ounces of extravasated blood is found in the right ventricle of the brain, and only a small quantity of serum in the left. It appears, therefore, that the severer injury of the brain had produced paralysis in the side of the body to which it virtually corresponded, whilst the slighter produced spasm. A certain degree of compression of the brain produces vomiting; a greater prevents or suppresses it: as we learn from the following passage in Abernethy's surgical observations. "In the insensibility from compression of the brain, the limbs are relaxed, and the retina and iris insensible to light; and no vomiting, when the pressure is great; for the action of vomiting betrays an irritability of the stomach and œsophagus." In concussion of the brain the same thing is observed: the vomiting is not present with the immediate and most severe effects of the injury, but comes on when sensation and other functions begin to be restored. A similar doctrine is held by Dr. Paris: "we find that vomiting will not take place, however forcibly the stomach may be goaded by emetics, when the energy of the nervous system is suspended, as in cases of profound intoxication, or in violent wounds and contusions of the head; while if the brain be only partially influenced, as by incipient intoxication or a less violent blow on the head, its irritability is increased instead of being paralysed, and vomiting under such circumstances is excited by the slightest causes: *the fact of such opposite results being produced by the same impulse in different degrees of intensity*, is no less

* Cullen's First Lines, p. 1099.

† Seats and Causes of Diseases. Alexander's Translation, vol. i, p. 22 et seq.

curious than instructive*." A small degree of deprivation of nervous energy, affecting the heart, produces palpitation; a greater, produces syncope or asphyxia†. Portal found that a slight pressure on the spinal marrow produced convulsions; a greater, produced paralysis‡. In the experiment of Dr. Yelloly, mentioned at p. 64, a strong and permanent spasm of the extremities is produced by *partially* dividing the spinal marrow; had it been *wholly* divided, perfect paralysis must have followed.

"In experiments on living animals by which the brain is injured, the muscles are convulsed on the side on which the injury is inflicted, and paralysed on the opposite§." Thus also Bichat: "In asphyxia from deleterious matters being conveyed into the lungs, two principal phenomena present themselves, spasm, and coma or torpor. In some cases there are violent convulsions; in others none, but instant insensibility and total paralysis. The same appearances arise when we expose the brain, and irritate or compress it. The irritation or compression produce coma or convulsions, according to the degree in which they are applied, and sometimes according to the disposition of the subject||."

The great principle of spasm and paralysis being produced by different degrees of one cause, forms a fundamental part of the theories of one of the most celebrated writers on pathology that the present age has produced, Dr. Parry; as the following extracts from a review of his work on that subject, in the Edinburgh Medical and Surgical Journal for January 1819, will show.

"He goes on to demonstrate, that irritation in the brain from sanguineous impulse produces excessive sensibility to external impressions, headach, vertigo, insanity, convulsions,

* Pharmacologia, vol. i, p. 156.

† Cullen's First Lines, par. 1360.

‡ Edin. Med. and Surg. Journal for January 1818.

§ Rees's Cyclopædia, article, Nervous System.

|| Recherches Physiologiques, p. 289.

delirium, epilepsy, hysteria, hypochondriasis, tetanus, sopor, catalepsy, &c. All of which he thinks are but modifications of effect from one common cause.

"'From what we are able to observe of the effect of different gradations of irritation or impulse on medullary substance in living animals, whether of brain, spinal marrow, or nerves, we see that a certain degree of it produces pain or uneasiness, which is often propagated onwards in the course of the medullary branches. This, I think, is the origin of the aura epileptica, which begins in the brain. A greater effect is more or less of convulsion. An increase of impulse, amounting to pressure, abridges the capacity of sensation and voluntary motion. The greatest impulse of all wholly destroys that of both.'"

The reviewers, however, observe:—"We cannot allow ourselves to admit the author's opinions in their full extent. We think he ascribes too much to sanguineous impulse, and too little to the constitution of the nervous system itself. By observation we know, that a number of causes acting directly on that constitution, and not through the medium of the circulation, are capable of instantly destroying the nervous influence, and thus producing death. Amongst other agents, the most conspicuous are *sudden bursts of grief*, the electric fluid, carbonic acid, carburetted hydrogen gas, and perhaps others of the deleterious gases, and some animal and vegetable *poisons*."

It is unnecessary to dwell longer on this part of the subject; for the paralytic affections which have been enumerated as occurring in cholera, admit only of one explanation—that they are produced by deficiency of nervous influence; and the circumstances under which they occur sufficiently point out, that it is the extreme degree of that cause which gives rise to them, for they are most prevalent in the weakest subjects, and they are always a symptom of the worst and most advanced stage of the disease.

SECT. II.

OF THE AFFECTIONS OF THE SECRETIONS.

1. *Of the Suppression of the Secretions.*

It is an established truth, that the process of secretion is immediately dependent upon nervous influence. The experiment of Mr. Brodie, before alluded to, and the important inferences which have lately been drawn by Dr. Wilson Philip, need only be cited in support of this position. That great feature of cholera, *the suppression of all the secretions*, is therefore explained on the supposition of diminution of nervous influence being the proximate cause of the disease; and is a very strong proof that that state is actually present.

In other diseases we find a more partial suppression of the secretions taking place; and apparently arising from diminution of nervous influence. I have already noticed the occurrence of this class of symptoms in the cold stage of fever. In the latter stages of phrenitis, when we may suppose that the brain is rendered nearly incapable of performing its functions by the disease, we find suppression of bile and urine taking place, accompanied by cold sweats, fluttering pulse, convulsions or coma*; and it would appear, when these symptoms of oppression of the sensorium and depression of the vis vitæ occur in other diseases, as in the last stage of low fevers, that they are usually accompanied by the suppression of the secretions. Is not this also the case in concussion of the brain?

Mr. Hey observes, "I have seen but few cases of the ischuria renalis, or complete suppression of urine by the kidneys. The disease proved fatal in all my patients except one; in whom it was brought on by the effect of lead, taken into the body by working in a pottery. It subsisted three days,

* Thomas's Practice of Physic.

during a violent attack of the colica pictonum; and was removed together with the original disease*." This remark exhibits a striking feature of similarity between cholera and colic. It also informs us, that the state of the system which gives rise to ischuria renalis is a highly dangerous one, agreeable to our experience in this epidemic, regarding both that symptom and the suppression of bile.

Dr. Darwin attributes paucity and paleness of the urine to palsy of the kidneys†. This at least is very certain, that dividing the nerves proceeding to the kidneys produces the suppression of urine.

But it is well known that the due performance of secretion depends upon the supply of blood, no less than upon the supply of nervous influence; and as the force of the circulation is usually much diminished in cholera, it may be conjectured that the suppression of the secretions is owing to that cause. This opinion, however, is directly contradicted by the fact, which has been frequently observed, of the white stools being present at the same time with a greatly increased state of the circulation‡.

2. *Of the Increase of Secretions.*

There is, however, another class of the affections of these functions, the explanation of which is not equally obvious—the excess of the secretions; evinced by the copious flow of bile in European cholera, throughout the disease, and in the common form of this epidemic after the favourable crisis; the watery discharges from the stomach and intestines in both, and by the excessive sweat.

The greater number of the symptoms of this disease may be divided into two distinct classes, and arranged under the heads of *increased* and *diminished* action; for such is its nature, that it frequently affects the same function in different

* Surgical Observations, p. 377.

† Zoonomia, vol. iii, p. 121.

‡ See the extracts from Dr. Burrell's Reports, &c.

persons in these opposite ways; and even in the same subject, there are many symptoms which are very constantly preceded or followed by their opposites. This has already been remarked in the affections of the muscles; it is still more evident in those of the secretions; and it will be found that it also holds good in the other functions.

Increase of secretions is an effect diametrically opposite to their suppression, as spasm is to paralysis; but in neither case does it follow that their causes should also be opposite; on the contrary, in numberless instances of the animal phenomena, we observe the same cause producing opposite effects, as I have already endeavoured to show. The general inference which has already been drawn from extensive practical observations in this epidemic, promises in some degree to reconcile the contradictions of this kind which it exhibits. The increased actions arise from a *smaller*, and the want of action or power from a *greater* degree of the disease.

It seems to be very evident, that the cholera of temperate climates is but a milder form or smaller degree of the Indian disease; and we accordingly find that the former is usually marked by a highly increased action of the biliary organ, and the latter by a total cessation of its function. It is an incontrovertible fact, that those cases of the epidemic in which the increased actions predominate, as violent spasms and retching, quick and full pulse, hot skin, and particularly the flow of bile, are more tractable and less dangerous than those of an opposite description, in which there is little or no spasm or vomiting, the suppression of nearly all the secretions, and extreme debility of the circulation.

The different periods of the disease are also marked by the predominance of one or other of these two classes of symptoms, which leads to the same conclusion. In the early stages, when the morbid affection exists in a moderate degree, the increased actions prevail—spasms, vomiting, purging, and increase of many of the secretions; as the disease advances to a fatal termination, they are all superseded by

the suppression of functions; and if the event is fatal, the increased actions never re-appear. But on the occurrence of a favourable crisis, when the degree of disease is again less, this class of affections, and particularly increase of secretions, again preponderates, as has already been shown. It has likewise been shown, that diminution or cessation of vital action has chiefly prevailed when the great external cause appeared to be at its height; and that increased action has frequently formed the principal feature of the disease under other circumstances.

It appears, therefore, that the smaller degree of the cause of muscular paralysis and suppression of secretions produces the increase of secretions, as well as spasms, in cholera; and as we cannot reasonably doubt that the former class of affections are owing to deficiency of the nervous fluid or energy, we may presume that the latter are produced by a partial deprivation of that principle.

Many of the circumstances of disease appear to support this position, for we frequently observe increase of the secretions attended by indications of diminution of the nervous energy. During the operation of an emetic, we perceive a great depression of all the healthy actions and powers of life; — debility, tremor, anxiety, and sinking of the spirits; and they are accompanied by a very remarkable increase of perhaps all the secretions. The bile is thrown off from the stomach in considerable quantities (and this is not to be accounted for on the supposition that the gall bladder is mechanically emptied by the action of vomiting; for in cholera there is excessive vomiting, and no bile ejected, though the gall bladder is found full, and its ducts pervious, on dissection): the watery secretions of the stomach are also in excess; and if the medicine is not quickly rejected, excessive secretion appears in the intestines, producing diarrhœa; copious sweat breaks out; the mouth fills with saliva; the eyes overflow with tears; and as I am informed by a practitioner on whose observation I can rely, a copious secretion of pale urine

also takes place. Diminished energy of the nervous system precedes and attends these affections, and it is probable that it is their cause. We observe nearly the whole of them in cholera; and they appear to cease, and to be followed by their opposites, from an increase of their cause.

If it is true that the depressing passions produce their effects by diminishing the energy of the brain, we have proof that excess of secretion may arise from defect of nervous energy. Many instances might be adduced of these agents increasing the secretions, but a few will suffice to prove the fact — the flow of tears and pale urine arising from grief, and the sweat and diarrhœa from terror. In the effects of grief we have a remarkable instance of both excess and suppression of secretions arising from the same cause. Thus a woman, on experiencing a common and slight affliction, will shed a copious quantity of tears; but let her, in the midst of it, be suddenly informed of the death of her husband or an only child, and the secretion will cease. She will shed no tears, but (if the energy of the brain is not entirely suspended so as to produce syncope) she will suffer a far more painful and dangerous state, characterized by the glassy eye, extreme anxiety, sinking, and a degree of stupor. When she begins to recover, tears will re-appear; they will be hailed by her attendants as a happy omen, and will be said to "come to her relief." That evacuation will be looked upon as the cause of her amendment, when, in fact, it is no more than a symptom of it. A moderate depression of the nervous energy had greatly increased the secretion — an extreme degree of the same cause suppressed it — and again, a smaller produced it in excess.

It is scarcely necessary to point out the perfect analogy which exists between these affections of the lachrymal gland, and those of the liver in cholera. In the milder forms of that disease we have frequently a copious flow of bile from the first; a greater degree of disease suppresses it; and the evacuation, when it re-appears, like that of tears in affliction, is

hailed as a happy omen. Both have been looked upon as causes instead of effects of the general amendment.

Dr. Park, in treating on the influence of mental impressions on the frame *, observes, that "tears are the effect of moderate grief, but that which is excessive suppresses the secretion, and gives rise to *convulsions,* mania, or *inflammation* of the brain." Inflammation is perhaps invariably attendant on suppression of secretion in cholera.

The general principle on which this explanation of the increased secretions in cholera is founded, has long been evident and acknowledged in the operation of the *vis medicatrix naturæ,* or that admirable arrangement of Providence by which the morbid states of the animal economy produce such actions in it as tend to restore health. These exertions of nature are *increased actions,* and they are usually produced by agents whose direct tendency is to *debilitate* the system †. When the process of digestion is arrested by a dose of ipecacuan, and nausea and anorexia are produced, no one will deny that the stomach is reduced to a state of debility; yet it is at the same time on the point of making violent exertions of strength, by which the cause of the morbid affection is got rid of. Increase of secretion, in particular, has been generally explained in this way; for it is the principal means which the system possesses of throwing off superfluous or noxious matter. In cholera itself we have some of the most remarkable instances of the operation of the vis medicatrix naturæ. A common and slight attack of that disease has frequently and justly been termed "a salutary effort of nature," both in common and professional language. It is usually produced by intemperance in food or drink, or other causes giving rise to torpor and *plethora,* particularly in the digestive organs.

* Journal of Science and the Arts.

† "It appears to be a law of the human economy, that a degree of debility occurring in any function, often produces a more vigorous exertion of the same, or at least an effort towards it, and that commonly in a convulsive manner."— Cullen's First Lines, p. 1360.

An excessive secretion and evacuation of bile, of the intestinal excretions, and of perspiration, appears, which is at once the symptoms and cure of the disease; and is succeeded by an unusual degree of health. It is probable that the excessive watery discharges which mark this epidemic are also salutary efforts of nature, for depletion has been found one of the most effectual remedies for cholera that have yet been discovered.

Physiologists have distinguished two principal modes of secretion, glandular secretion, and exhalation; and it is remarkable that the increase of secretion in the ordinary description of cases of the epidemic (that is, previous to the favourable crisis) is confined to the latter, and that the suppression is much more remarkable in the former. The secretions of bile and urine are completely suppressed from the first, while those of the skin and intestines are in excess until the disease reaches a certain degree, when the suppression extends to one, and probably to both of them also. These circumstances are what we should, a priori, be led to expect from a consideration of the different structure and functions of the organs which perform the offices of exhalation and glandular secretion. The glands are complex organs, and their functions are to produce fluids from the blood which are very different from those contained in it; the exhaling surfaces are simple in their structure, and appear to have little more to perform than mere filtration: hence we should infer that the functions of the former are more difficult (if the expression is admissible) than those of the latter; and that they would require a greater degree of the vis vitæ to enable them to continue their action.

The evolution of animal heat has of late been looked upon as a secretion, effected by the agency of nervous influence on arterial blood. Whether this idea is perfectly correct or not, is immaterial in the present instance; for it is generally admitted that the calorific function is immediately dependent on nervous influence. The remarkable coldness of the body

which usually occurs in cholera is therefore to be attributed to the diminution of nervous influence; and is another almost undeniable proof, that that state is actually present in the disease.

In the cold stage of fever, and in concussion of the brain, this symptom is also present. In the former instance it is referred by the best authorities to diminished energy of the brain; and in the latter it is evident that it has the same origin, for the brain is rendered nearly incapable of performing its functions by the injury.

Our experience in this disease supports the opinion of animal heat being a secretion; for the coldness of the body usually appears with the suppression of the principal secretions, and is at its greatest height when that suppression is general, until, at least, inflammation gains ground. Like the secretions too, it is also found in excess as well as diminution; and these variations appear to be all subject to the same laws; for increased heat of the surface (except when it arises from the inflammatory nisus), as well as the other increased actions, is a symptom of a slighter form of the disease. It accompanies the excessive flow of bile which precedes recovery. It is probable therefore that the changes which the temperature of the body undergoes in cholera, have the same proximate cause as those of the secretions.

The secretions in cholera exhibit considerable variations from the state of health in quality as well as in quantity. The sweat is observed to be clammy. The urine, when it does appear in the severe stages, is pale and watery; as in the cold stage of fever and in hysteria. When there is much heat of skin I have observed it of a high colour. Does it deposit the lateritious sediment after the favourable crisis, as in the sweating stage of fever? The bile is of three colours, black, green, and yellow; and these different appearances seem to indicate different degrees of morbid affection of the liver. The black bile appears to be a highly vitiated secretion, and to prevail most in the severest cases in which the secretion

returns, particularly in such as terminate fatally, notwithstanding this favourable symptom. Green bile is very common; and is probably vitiated in a less degree. Yellow bile is the most favourable, as that is the natural colour of the secretion, and its appearance would indicate that the healthy action of the secretory organs is returning. I confess, however, that I have not observed a sufficient number of facts to establish these conclusions. Does not the black bile, when in its highest degree of vitiation, assume a blue tinge? If this is the case, we may conjecture that green bile is a mixture of that secretion with the natural yellow bile*? I must, however, admit that the green colour of bile is attributed by some to the presence of an acid. But do not physiologists also inform us that healthy feces contain a free acid?

The intestinal secretions also differ much, not only from those of health, but from common diarrhœa. They possess a very peculiar, faint odour, wholly different from the natural discharges. They appear to contain no feces, after the first evacuations, and they are occasionally observed to be nearly as white as milk; a circumstance which the absence of bile alone is insufficient to account for.

Dr. Darwin has attributed this appearance, in the case of cholera, noticed at p. 23, to an inverted action of the lacteals, by which the chyle they contained was supposed to be thrown back into the intestines. There can be little doubt that the white stools of cholera are owing to chyle being either thrown out by the absorbents, or simply hurried off by the violent action of the intestines, without being absorbed. And though we have no proof of inverted action of the lacteals, it is probable, not only from the white stools, but from other circumstances which shall subsequently be adverted to, that

* Dr. Heyne informs us, that one of the seven principal objects of observation, laid down in Hindoo works on medicine, as means of forming a just prognosis in any disease, is "the colour of the feces, whether they be black, green, or yellow."— Tracts on India, p. 32.

these vessels partake of the general debility or paralysis; and that consequently the chyle is allowed to pass off unabsorbed, and even that which they had already taken up to flow back.

Dr. Tytler, the well-known indefatigable defender of an exploded theory (that bad rice is the great cause of the epidemic), presents us with another explanation of the white stools of cholera, which has at least simplicity to recommend it. He assures us that they not only resemble conjee (decoction of rice), but actually consist of that hitherto culinary production, prepared in the bowels from the poisonous rice which had been eaten. But the epidemic has been found to prevail with equal severity in parts of the country where rice is not a common article of food amongst the poorer classes; and in innumerable instances it has attacked Europeans without their having eaten rice of any kind. Theory, like contagion, has an *assimilating* power, by which it converts every thing which it reaches to its own nature, even white stools into conjee; and (to indulge in another analogy) like *religious* fanaticism, it seems to receive fresh vigour from opposition.

SECT. III.

OF THE AFFECTIONS OF THE SENSES.

The morbid sensations in cholera are very numerous. Those alone which have their seat in the stomach or its neighbourhood are no less than five in number: *nausea, pain, heat, thirst,* and a peculiar, indescribable sensation, to which the terms *oppression, anxiety, weight,* and *gnawing* have been applied.

The nausea has already been considered in connection with vomiting. The burning and pain at the stomach are amongst the most remarkable and constant symptoms of cholera. They appear to arise from inflammation of that organ, and will be adverted to under that head.

The thirst is also a very remarkable symptom, and is scarcely ever absent in severe cases. Its urgency can scarcely be imagined by those who have not seen this disease. It is perfectly surprising to see a person, whose body is quite cold to the feel of another, incessantly exerting all the remains of his strength in exclamations for *cold water*. An intemperate and bloated European, who seldom tastes the pure element, and the spare Hindoo, whose sole beverage it is, feel the same uncontrollable desire for it; and nothing but *cold water* will satisfy them. I have known persons of the former description refuse, and express abhorrence at spirit and water, or hot liquids of any kind, though they were making the most urgent complaints of thirst. In many instances it appears to be unquenchable, for however much is drank no relief is found.

This singular affection is clearly the *sitis frigida* of Darwin, which is peculiar to a small number of diseases. Its occurrence in cholera would appear, at first sight, to arise from the suppression of the secretions, occasioning a deficiency of diluting fluids in the mouth and primæ viæ; but when we observe it accompanied by excessive discharges of watery fluid from the stomach and intestines, and that it is frequently not relieved by drinking, we cannot infer that this is its sole, or even principal cause. In the lucid pages of Darwin we find a probable explanation of this difficulty. He observes: "The remote cause of sitis frigida, or cold thirst, is the inaction of the cutaneous, pulmonary, urinary, and cellular absorbents; hence the blood is deprived of the great supply of moisture which it ought to receive from the atmosphere and from the cells of the cellular membrane, and from other cysts; this cause of thirst exists in dropsies, and in the cold fit of intermittents *." There are also other causes in cholera for deficiency of the aqueous part of the blood, as the excessive

* Zoonomia, vol. i, p. 397.

sweat and secretion from the intestines. The inactive state of the absorbents of the primæ viæ appears to be proved by, and at the same time explains, the circumstance of the thirst not being relieved by drinking; for it is evident that if these vessels are unable to take up the fluid that is presented to them, it cannot supply the deficiency of dilution which the desire for it indicates. Agreeably to these views, it has been commonly remarked that the blood drawn in this disease is not only of a darker colour but thicker consistence than natural.

The anxiety or oppression about the præcordia, though referred to the situation of the stomach, appears to differ in its seat as well as nature from the above-mentioned sensations. It seems to be a common and peculiar affection, which is generally believed to be seated in the great semilunar ganglion, or centre of the sympathetic nerves, situated behind the stomach and before the crura of the diaphragm *. This sensation precedes and accompanies the cold stage of fever, as I have frequently observed in my own person. It is very common even in health, in nervous habits. It is very remarkably produced by sudden grief or terror, or any of the depressing passions; and appears to have been formerly referred to the heart, and with other sensations which have the same situation, to have occasioned that organ to be looked upon by the ancients as the seat of the passions; an attribute which, in common language, it still maintains. The word *remorse* itself, from its derivation, conveys a pretty accurate idea of the nature of this sensation; for the epithet *gnawing*, which I have heard applied to it by patients in cholera, appears its most expressive designation. It has probably given rise to the beautiful allegory of the punishment of Prometheus, in which the effects of remorse are strikingly pourtrayed by a vulture *gnawing the vitals*.

* Richerand's Physiology, p. 41.

Mr. Brodie, whilst engaged in a course of experiments which have very satisfactorily proved that the essential oil of bitter almonds causes death by destroying the nervous energy, touched his tongue with a small portion of that poison, and instantly experienced a peculiar, *indescribable* sensation in the epigastric region, accompanied by an approach to syncope*. We can scarcely doubt that this affection was the same as that under consideration. In this instance it was evidently produced by diminution of nervous energy; and we may infer that its proximate cause is the same in the effects of the depressing passions, in the cold stage of fever, *and in cholera.*

Vertigo, which is a very constant symptom of cholera, appears to arise on all occasions when the powers of life are suddenly diminished. Thus, a violent blow on the head produces it. It invariably precedes the total suspension of the animal functions in syncope; and, as these functions are performed by the energy of the brain, we may conclude that vertigo is owing to the diminution of that energy. It accompanies nausea, which is attended by a remarkable depression of the vital powers. It is probable that these and similar circumstances have induced Darwin to refer this symptom to a deficiency of sensorial power, in the following passage: "Vertigo from injuries of the brain, either from general violence, or which attend paralytic attacks, is owing to general deficiency of sensorial power. In these distressful situations the vital motions, or those immediately necessary to life, claim their share of sensorial power in the first place, otherwise the patient must die; and those motions which are less necessary feel a deficiency of it, as those of the organs of sense and muscles, which constitutes vertigo; and, lastly, the voluntary motions which are still less immediately necessary to life, are frequently partially destroyed, as in palsy, or

* Med. and Phys. Journal for August 1811.

totally, as in apoplexy. Vertigo in fevers either proceeds from the general deficiency of sensorial power, or greater expenditure of it on certain motions*."

Tinnitus aurium, is a symptom which seems universally to accompany the greater degrees of vertigo. It perhaps never fails to accompany the slighter degrees of deafness, and to precede the total destruction of hearing; which, when unattended by evident organic injury, is known to arise from paralysis, or total want of nervous influence, in the ear. The latter symptom is also frequently present in cholera, and, as on other occasions, it is preceded by tinnitus aurium. Mr. Charles Bell has observed, that the *muscæ volitantes* are a symptom analogous to tinnitus aurium. Accordingly it would appear that the former precedes or accompanies the blindness of cholera, as the latter does the deafness. These affections, as well as vertigo, appear to be irregular increased actions, somewhat analogous to spasm in the muscles†, and produced by a less degree of privation of nervous influence than that which gives rise to perfect insensibility of the organs in which they have their respective seats.

Headach, is frequently a symptom of a slighter and more continued affection of the brain, arising from the same causes with vertigo. Thus continued mental annoyance will produce it. A blow on the head gives rise to it, when the brain is beginning to recover from the injury. During the existence of the worst symptoms of cholera, I have not generally observed it. It appears to be most prevalent in the beginning of the disease, and in robust and intemperate subjects. It is one of the most common symptoms of the extensive class of affections which have received the name of *nervous;* many of

* Zoonomia, vol. i, p. 201.

† Darwin supposes that sensations proceed from fibrous *contractions* of the nerves. The *vibratory* nature of the ringing in the ears appears clearly to be analogous to the minute contractions and dilations, or tremor, which incessantly take place in a contracted muscle.

which may be directly traced to debility of the nervous system*.

Vertigo and tinnitus aurium appear to be usually the first symptoms which appear in the most sudden and violent attacks of cholera; and in the milder and more gradual, I have often found that headach and vertigo have been first felt. These facts are in support of the opinion that the brain is the principal seat of the disease; but allowing that they are not of general occurrence, it will not destroy the inference; for the passions of the mind are known to produce various phenomena in the frame, through the brain, without invariably producing morbid sensation in that organ.

Headach, vertigo, and tinnitus aurium, are all very constant forerunners of apoplexy; a disease which we know to have its seat in the brain, and, according to the highest authorities, to consist of a deprivation of nervous influence in the animal functions. We find also that apoplexy and cholera have various other affections in common, stertor and other disorders of respiration, and stupor or coma; in fact, these and other symptoms in cholera are frequently such as to indicate the presence of apoplexy itself.

The *suppression* of the senses, though of later and less general occurrence, is scarcely less remarkable than that of the secretions. Blindness and deafness have been very frequently remarked in the beginning of the more sudden and violent attacks, and towards the conclusion of fatal cases; particularly in weakly habits, whose animal functions are performed in a less energetic manner than those of others. These affections are only to be accounted for on the supposition of deprivation of nervous influence in the organs of sense, and that state is clearly referrible to the diminished energy of the brain. The stupor, when it reaches the extent of perfect coma, consists of a total abolition of the animal functions, which irresistibly leads to the same conclusion.

* Trotter on the Nervous Temperament.

The sense of numbness in the extremities, so commonly complained of in cholera, is the very same as that produced by pressure on the crural nerve in sitting, and evidently arises from the same proximate cause.

One of the more remote causes of the stupor or coma, appears to be venous congestion in the brain. It is known that the venous system in the internal parts of the frame is generally gorged with blood in this disease; and dissection has shown that this is very remarkably the case in the brain: during life also we frequently observe symptoms which lead to the same inference, as turgesence of the vessels of the eye*, and flushed face. It is probable, therefore, that this state *increases* the interruption to the functions of the brain by its pressure on that organ. More than this we cannot attribute to it; for we have no evidence of its existence at the commencement of the disease. The nausea and vomiting are found to be remarkably increased by the upright posture: if the disease depended primarily on fulness of the brain, this should relieve it, by lessening the quantity of blood in that organ.

Are the senses of the taste and smell lost in the latter stages of cholera? From analogy we should expect that this would happen†.

In the senses as well as in the other functions we observe some appearances of exacerbation as well as of inaction. The anxiety is a state nearly opposite to the stupor which follows

* An appearance resembling this may be produced at pleasure by increasing the quantity of blood in the head. On tying a ligature round the neck so as to interrupt the return of the venous blood, the face becomes flushed and of a dusky hue, and red vessels are seen to start out on the conjunctiva, towards the cornea.

† Since this was written, I have been informed of an instance where the sense of taste was entirely lost early in the disease. The patient (an officer) expressed his surprise that brandy and water appeared to him perfectly tasteless. This symptom may have prevailed generally without having been much noticed, as it would rarely be observed unless inquired for.

it. The former appears to be attended with excessive sensibility to painful impressions; for the sufferers are observed to be easily annoyed and irritated by trifling circumstances, such as being obliged to remain covered with bed-clothes; and I have seen them scream from pain on being put into the warm bath, though it did not appear sufficiently warm to the feelings of a person in health. I have observed a cholera patient to be thrown into a perfect paroxysm of terror and irritation, such as we see in hydrophobia, by the approach of a wasp.

Increased sensibility is a very common attendant on debility and disease. Persons of *weak nerves* are well known to be generally gifted with the greatest share of sensibility. Mr. H. Earle finds the upper part of a palsied limb possessing the natural degree of sensibility; a lower part *morbidly sensible;* and the extremity insensible*. Does not this prove that a smaller degree of deprivation of nervous influence produces increased sensibility, whilst a greater entirely suppresses it? Huxham has observed excessive sensibility of the skin preceding paralysis from colic†.

The senses of sight and hearing have not been observed to be morbidly increased in this disease; and their suppression is earlier and more marked than that of feeling‡. Does not this bear an analogy to the difference of the affections of the glandular and exhalant organs before mentioned? The eye and ear, like the liver and kidneys, are specific and complex organs; the sense of feeling, like exhalation, appears a more simple process, and is common to extensive surfaces: in the former class the suppression of functions predominates, in the latter the exacerbation.

Dr. Marshal, in his treatise on the brain, &c. has detailed a case of hydrophobia, in which some observations similar to these were made. The sensibility of the skin was found to be highly increased, at the same time that that of the other organs

* Medico-Chirurgical Transactions, vol. vii.

† Treatise on Fever, Devonshire Colic, &c.

‡ Diminished sensibility of the surface is enumerated by the Bengal Medical Board among the symptoms of the disease. See Appendix.

was diminished; and heat, cold, and liquidity of the bodies, which are distinguished by the sense of feeling, were perceived more than their taste, which is the object of a specific organ. Towards the conclusion of the disease blindness came on, and afterwards deafness. As in cholera, too, the eyes were observed to be fixed and dim.

The transition from anxiety to stupor, occurring in the latter stages of cholera, is obviously explained on the same principles as that which takes place in the voluntary muscles and the stomach and intestines, from a spasmodic state, to torpor, extreme debility, or paralysis; as the transition from excess to suppression of secretions; and (as will subsequently be more particularly noticed) from a highly increased action of the heart, to the lowest degree of that action which is compatible with life. These remarkable changes are all perfectly analogous to each other; and they appear clearly to be all in consequence of an increased degree or continuance of the cause of the increased actions which precede them. They are far from being all of universal occurrence, for, as has already been frequently remarked, there are many cases in which increased action does not appear at all in many functions, consequently the transition from that state to its opposite cannot take place.

In the periods of the disease at which these changes occur there is also much variety. It may be generally remarked, that the transition from increased to diminished action of the heart appears to be the first of the series; from increased to suppressed secretion the next; the cessation of spasm, and commencement of muscular torpor or paralysis, the third; and the transition from anxiety to stupor the last, and nearest to the fatal event.

The cold stage of fever, the depressing passions, the approach of syncope, and probably all instances of general and great diminution of nervous energy (when it is not such as immediately to suspend all sensation), are attended by anxiety; and we may clearly infer that on all these occasions, as well as in cholera, it has the same proximate cause.

The anxiety of cholera is probably the most painful and distressing of all affections; at least, I have seen nothing of suffering which so strongly awakens feelings of commiseration. It appears to consist of the utmost degree of depression of spirits, and an urgent sense of *want*, which the sufferers are incessantly attempting to relieve by tossing about, getting up, and making various other muscular efforts. If it should be proved that pleasure arises from an increased quantity of nervous fluid in the nerves, it would appear that the anxiety of cholera arises from the opposite state; for it is diametrically opposite to the general sense of pleasure which is denominated the *flow of spirits*. And is not this term another instance of the correctness of familiar language, derived from old, but neglected ideas? If the depressing passions are attended with a diminution of nervous energy, and, consequently, a deficiency of the nervous fluid, it is probable that their opposites, as hope and joy, will produce the opposite state, or an abundance of the nervous fluid, the *spiritus animales* of our ancestors, or the *spirits* of common language.

SECT. IV.

OF THE AFFECTIONS OF THE CIRCULATING SYSTEM.

The healthy action of the heart is believed to be produced by the stimulus of the blood, acting upon the vis insita, or principle of irritability, which that organ, in common with other muscles, contains; and, as we have much proof that the change from venous to arterial blood is imperfectly performed in cholera, an opinion has been entertained in this country, that the debility of the circulation in the disease is owing to the want of the stimulus of arterial blood in the heart. But Bichat has shown that venous blood is equally capable of causing the contraction of the heart with arterial.

In animals killed by suffocation he found the heart propelling venous blood into the arterial system. When the action of the heart had ceased, he reproduced it by injecting venous blood into the organ. And, indeed, experiments were unnecessary to convince us of this fact, for we know that the action of the right side of the heart is constantly maintained by venous blood, as well as that of the left side by arterial. According to the most modern and received opinions, the contraction of the heart is owing to simple *distension* from the influx of blood. It is not, therefore, on the supposition of the insufficient change of the blood from the venous to the arterial state, that the diminished action of the heart in cholera is to be immediately accounted for.

As the debility of the circulation usually appears at the same time with the spasms of the muscles, it has been supposed to be produced by the spasmodic action extending to the heart and arteries: and an opinion of Bichat's seems to countenance this idea. He concludes that the heart is affected by spasm in syncope or asphyxia, produced by the violent passions of the mind. But in tetanus we observe similar spasms in the muscles without the heart being affected; and in those cases of cholera in which the spasms are most violent, the circulation is often, nay generally, least depressed: on the other hand, in the most debilitated habits, in which spasms frequently do not occur at all, the pulse sinks most rapidly. In all fatal cases, this symptom continues after the muscular spasms have ceased: and, in short, we have no reason to attribute it to any other cause than simple debility of the heart and arteries.

Dr. Cullen, in explaining the weak action of the heart in syncope, observes: "I must assume a proposition which I suppose to be fully established in physiology. It is this: that though the muscular fibres of the heart be endowed with a certain degree of inherent power, they are still, for such action as is necessary to the motion of the blood, very constantly dependent upon a nervous power sent into them from the

brain. At least this is very evident, that there are certain powers acting primarily, and perhaps only, in the brain, which influence and variously modify the action of the heart. I suppose therefore, a force very constantly during life exerted in the brain with respect to the moving fibres of the heart, as well as every other part of the body; which force I shall call the energy of the brain; and which I suppose may be, on different occasions, stronger or weaker with respect to the heart*."

The instances in pathology where diminished action of the heart and other parts of the organic system appears to be the immediate consequence of diminished energy of the brain, are innumerable; and some of them, as syncope from rising suddenly from the recumbent posture (whence the brain is deprived of its due quantity of blood), are so instantaneous as to preclude the supposition that they are owing to the disturbance of respiration, which is known to depend upon the brain. But modern discoveries appear to show that the heart is not thus immediately and entirely dependent on the brain. Mr. Brodie maintained the action of the heart *for a time* without the agency of the brain; and Dr. Wilson Philip has inferred from experiments, the accuracy of which cannot be questioned, that "the heart is independent of, but influenced by the brain." The opinions of Bichat on this point are nearly the same. These positions, though admitted in their fullest extent, do but transfer the opinion of the agency of the brain in this function, to the system of the sympathetic nerves, without in the smallest degree invalidating the supposition that the natural action of the heart is dependent upon nervous influence; and we have one plain fact, which alone is sufficient to establish it; a ligature on the nerves going to the heart immediately stops its motions†.

On these principles we are under no difficulty in explaining

* First Lines, Par. 1175.

† Cullen's First Lines, Par. 1175. Note by the Editor.

the extreme debility of the circulation in cholera: it is evident that the diminished energy of the nervous system, by diminishing or suppressing the supply of the nervous fluid or energy to the heart, may weaken, and finally suppress its movements.

Dr. Darwin has attributed suppression of the heart's action to deficiency of sensorial power. He observes: "When fear has still more violently affected the system, there have been instances where syncope and sudden death, or a total stoppage of the circulation, have succeeded. In these cases the pain of fear has employed or exhausted the whole of the sensorial power; so that not only those muscular fibres generally excited by volition cease to act, whence the patient falls down, and those which constitute the organs of sense, whence syncope; but lastly, those which perform the vital motions become deprived of sensorial power, and death ensues *."

The sinking of the circulation is certainly the most urgent if not the most characteristic of all the symptoms of cholera; and the rapidity with which it supervenes in spare habits is truly surprising. In a great majority of all kinds of cases the pulse becomes extremely small and weak on the accession of the more severe symptoms; but in the weakly natives nothing is more common than for it to disappear entirely from the wrist on the appearance of the first fit of vomiting, or the first stool.

The *quickness of the pulse* in cholera also is to be attributed to deficiency of nervous influence in the heart. "The times of contraction of the muscles of enfeebled people being less, and the intervals between these contractions being less, accounts for the quick pulse in fevers with debility and in *dying animals*. The shortness of the intervals between one contraction and another, in weak constitutions, is probably owing to the general deficiency of the quantity of the spirit of ani-

* Zoonomia, vol. iv, p. 318.

mation; and that, therefore, there is a less quantity of it to be received at each interval of the activity of the fibres*." It may also be observed, that quickness of the pulse usually, if not always, accompanies extreme smallness of it, on all occasions.

In the circulation, no less than in the other functions, we observe evident marks of *increased* as well as diminished action; and the observation that has already been applied on so many similar occasions holds good also here. The fulness and hardness of the pulse, whenever they occur, are symptoms of a smaller degree of disease than its smallness and weakness. In a considerable number of instances I have met with a very full and bounding pulse, with or without heat of skin, at the commencement of the disease; and in all cases the circulation is usually considerably increased after the favourable crisis, and before it regains the standard of health.

It must, however, be observed, that the former description of cases is not very common; and the increased action of the heart usually ceases in a short time, giving place to the debility which is so much more characteristic of this disease. They are of much more frequent occurrence in robust habits; and are, doubtless, in some degree owing to habitual excessive irritability of the heart, participating in the excessive tone of the system, which, however, is quickly exhausted. In those cases in which the spasms are most violent, the circulation appears usually to be most increased and least debilitated.

In palpitation of the heart and syncope we have analogous instances of these opposite affections of the circulating system. They are usually produced by the same causes; and it is evident that the former is the slighter affection, and that it arises from the smaller degree of cause. Cullen observes: "A fourth head of the cases of palpitation is of those arising from causes producing a weakness of the action of the heart,

* Zoonomia.

by diminishing the energy of the brain with respect to it. That such causes operate in producing palpitation, I presume from hence, that all the several causes mentioned above (1177 et seq.) as in this manner producing syncope, do often produce palpitation. It is on this ground that these two diseases are affections frequently occurring in the same person, as the same causes may occasion the one or the other, *according to the force of the cause* and the mobility of the person acted upon. *It seems to be a law of the human economy, that a degree of debility occurring in any function often produces a more vigorous exertion of the same, or at least an effort towards it, and that commonly in a convulsive manner*.*

A very important class of affections of the sanguiferous system still remains to be considered—the *inflammation* of various parts, which so constantly occurs in cholera. In the infancy of our experience in the disease, many persons were inclined to doubt that the appearances exhibited by the stomach and intestines on dissection were actually produced by inflammation; and to attribute them to the general venous congestion. In the fourth volume of the Medico-Chirurgical Transactions, is an interesting paper by Dr. Yelloly, which countenances this opinion. That gentleman relates numerous instances of great vascularity in the inner coat of the stomach, occurring in cases where no suspicion was entertained, during life, of inflammation of that organ; and, both from the description and plates annexed, it appears to have borne a striking resemblance to the appearance of the stomach in the more rapid cases of cholera, where the marks of disease exhibited by that viscus are but slight. Many of the cases in which they were noticed were executed criminals; and Dr. Yelloly attributes them to accumulation of blood in the minute veins.

* First Lines, P. 1360.

There is scarcely, however, in the present day, any doubt concerning the origin of the appearances alluded to in this epidemic. They are frequently accompanied during life by the specific symptoms of the various phlegmasiæ which produced them. Inflammation of the brain is indicated by delirium, stupor, redness of the eyes and face, and pyrexia. Enteritis may be inferred from the acute continued pain in the bowels, which is occasionally met with, or the pain on pressure which very commonly occurs, together with a very sharp small and quick pulse, and hot skin. And the inflammation of the stomach is indicated by perhaps all the symptoms which are described by authors as characteristic of that affection. Pyrexia *typhodes; anxietas; in epigastrio ardor et dolor*, ingestis quibuslibet auctus; vomendi cupiditas; ingesta protinus rejecta; singultus." "There is a great degree of pain and tension at the pit of the stomach, increased by the slightest pressure, accompanied with a burning heat in that part; the anxiety is inexpressible; there is constant retching, vomiting, hiccup, and a considerable degree of pyrexia; the pulse is commonly frequent, small, contracted, and hard; the thirst is urgent; and there is a greater and more sudden depression of strength in this than in any other of the phlegmasiæ*."

Gastritis erythematica is said by Dr. Clarke frequently to run through the whole of the intestinal canal. The pain at the stomach in cholera possesses the infallible character of the phlegmasiæ—being increased on pressure. On dissection also we frequently find the morbid appearances of cholera so perfectly characteristic of inflammation, that we cannot doubt that they are consequences of that affection. The minute *arteries* of the dura mater are found highly injected, which cannot arise from venous congestion. Moreover, these affections are in many instances found running on to gangrene; a fact which is confirmed by Dr. De Gravier, the principal

* Clarke's Practice of Physic.

French physician at Pondicherry, who informs us that they are frequently found to assume a violet and even a black colour. This gentleman considers the inflammation of the stomach and intestines as the primary affection in the epidemic, giving rise to all the other symptoms by means of irritation; and he has gone so far as to name the disease *gastro-enteritis*. It does not, however, appear that he has gained any proselytes to this opinion. Spasms are nowhere enumerated among the symptoms of gastritis or enteritis. A person is walking along in perfect health, previous to an attack of the epidemic, and in an instant perceives all the objects around him appearing to turn round, and fading from his sight; he falls down, retches, and his pulse is found to have disappeared from the wrist. Is this from inflammation of the stomach*?

If the identity of many of the appearances of the stomach in cholera with these noticed by Dr. Yelloly shall be proved, it will be much more easy to imagine that the latter actually

* Dr. De Gravier argues thus:—

——— "Toutes les affections spasmodiques font partie de l'irritation. Rendus a ce point, ouvrons maintenant un homme mort du Cholera. Nous trouvons la muqueuse qui tapisse l'estomac toute rouge, parsemée de taches violettes, quelquefois noires, signes certains de phlegmasie.

"Rapprochons maintenant les symptomes pendant la malidie—tension d'epigastre, sentiment d'ardeur et de douleur, tres aigue de l'estomac, accompagneés de nauseés, de vomissemens, de difficulte de respirer, de soif ardente, de petitesse et de frequence dans le pouls, de froid aux extremités. N'est ce pas la une Gastrite? Explorons le canal intestinal, nous trouvons sa muqueuse phlogosée, et presque desorganisée. Rapprochons encore les symptomes — douleurs aigues, dejections sereuses, avec des mucosités. N'est ce pas la une Enterite? Qui peut donc s'opposer a ce qu'on appelle l'epidemie gastro-enterite. *Cette maniere de proceder n'a rien d'arbitraire.* **** Les spasmes des muscles de l'abdomen et de la poitrine prouvent l'exuberance des forces attirées par l'irritation."—MS.

Dr. De G. asserts that the epidemic had swept off two millions of persons in India in the beginning of 1819.

were inflammation, than that the former were not. In fact, the plates annexed to Dr. Yelloly's paper convey so perfect an idea of their being the consequences of inflammation, that it is difficult to admit any other belief. In almost all diseases we find the stomach affected with nausea and other uneasy sensations, and we need not be surprised if these affections are attended with a slight degree of inflammation. And in the cases of the executed criminals, it must be recollected that they cannot have been *in health* at the time of their execution. They must have been affected with extreme anxiety, depression of spirits, oppression about the præcordia, and probably a hurried and depressed circulation. Is it then surprising that they should exhibit another of the symptoms of cholera, inflammation of the stomach? We know that the depressing passions are capable of producing many morbid affections of the human frame; and it was even to be expected that the highest degree of mental suffering, which must have been experienced by these unfortunate men, would leave behind it some physical traces of its existence. If, indeed, similar appearances to these were found in the stomachs of men killed in battle, or in carnivorous animals slaughtered in health, it would be proved that they are not preternatural.

The inflammation of the stomach and intestines in cholera appears to be of the *erythematic* kind. The acute pain and burning at the stomach are precisely similar to the sensations which erysipelatous inflammation produces on the surface of the body. The morbid appearances are found to be in a great measure confined to the villous coat of the stomach and intestines, as occurs in gastritis erythematica. They are usually of the dark red, or crimson colour; and I have never observed the adhesions of the intestines to each other, which we frequently find in common inflammation of them. This distinction is farther supported by considering the state of the system in which these affections occur. It is usually one of extreme debility in all the functions; and we know that

erythematic inflammation is most prevalent under such circumstances, while from similar remote causes the phlegmonic arises in robust and firm habits. Thus a blow in a healthy subject will be followed by the latter affection, ending in resolution or suppuration; and in another, whose constitution is debilitated by drunkenness or disease, by erysipelas running on to gangrene. John Hunter observes, that erysipelatous inflammation often arises spontaneously in consequence of a low and debilitating fever*.

In attempting to account for the inflammatory affections of cholera it is necessary in the first place to observe, that they are of too general occurrence throughout the frame to be attributed to any cause whose operation is confined to particular parts of it. Had inflammation existed only in the stomach or brain, we might have supposed it to arise from some particular affection of one or other of these viscera; but when we find it occurring not only in both these parts, but in the intestines, the liver, the heart, and the lungs, on the surface of the body and in the veins, we cannot but conclude that these affections have some common cause, which exists throughout the whole of the sanguiferous system.

To enable us to form a satisfactory explanation of the nature of this cause, it is necessary to possess an accurate knowledge of the pathology of inflammation itself; and that, it is to be feared, is still a desideratum in medicine. An increased action of the smaller arteries of a part is generally looked upon as its proximate cause; but this, even if proved, is advancing but a small step in the inquiry; for when the affection arises spontaneously, or from constitutional causes, we are still entirely ignorant of the immediate cause of this increased action; and even when it is evidently produced by a *stimulus*, we cannot form any idea of the way in which the effect arises from the cause. It is said that the words *stimulus* and *sympathy* are "mere subterfuges for ignorance;" and it is evi-

* Hunter on Inflammation, &c., vol. i, p. 476.

dent that they are no more than general terms applied to express certain classes of facts with whose immediate causes we are unacquainted. The fact that "inflammation is produced by a stimulus," conveys little more information concerning it than the fact that "inflammation is a consequence of cholera." Nevertheless these general inferences are highly valuable; for it is of this kind of information that the science of medicine is composed.

The essential meaning of a *stimulus* is some cause productive of action or increased action; and it is evident that such a cause exists in cholera. Irritation, or the effect of a stimulus, is marked by increased secretion in the secretory organs, spasm in the muscles, pain in the nerves, and inflammation in the arteries; all of which are prominent features of cholera. A few grains of arsenic taken into the stomach produce all these symptoms in the whole alimentary canal, precisely the same as we find them in cholera; and we see that in that instance the inflammation is owing to the same immediate cause with the other affections. Inflammation is no casual or occasional occurrence in cholera, but as intimately connected with it as cause and effect, or rather as disease and symptom, can be; for it constantly arises when the disease has attained a certain height, and becomes evident on dissection, when this state has continued sufficiently long to enable it to show itself. Upon the whole, then, we can scarcely doubt that the inflammations of cholera have the same proximate cause with the other increased actions; or, in a word, with the disease; and, if any credit is due to the preceding speculations, that cause is diminution of nervous energy.

It is, however, very evident that there are some objections to this generalization. The inflammations do not appear to bear the same relation to the degree of disease with the other increased actions; on the contrary, at those periods of the disease in which the latter prevail most, the former are frequently least evident, and vice versa. We have seen that the excessive flow of bile, the full pulse, and the violent

spasms, are indications of a moderate degree of disease, and consequently are comparatively favourable symptoms; but inflammation, when it rises to any height, is a very fatal affection. And, in particular, it is very commonly in an inverse ratio to the other increased actions of the circulating system, which are indicated by the fulness and strength of the pulse. *All* the other increased actions are constantly found to cease from the increase of the state which produced them, but the inflammations run on with increasing violence till death.

But these circumstances do not destroy the arguments which we derive from the most direct analogies, that all these affections have a common proximate cause; they only inform us that inflammation, from some peculiarity with which we are unacquainted, requires a greater degree, or at least a longer continuance, of that cause to become equally evident; and that it flourishes under such a degree of disease as paralyses the other actions;—for in the last stage, when the secretions are all suppressed, the senses nearly abolished, the pulse extremely small, and the voluntary muscles reduced to debility bordering on paralysis, or completely paralysed, we have evidence of acute inflammation going on in the stomach, intestines, or brain; and no increase of the disease short of death appears capable of putting a stop to it.

It is not in cholera alone that diminution of nervous energy appears to give rise to inflammation. Apoplexy is believed to consist in an abolition of functions, or an "obstruction" in a portion of the nervous system; and when fatal, it is very commonly attended by inflammation of the brain. Dr. Abercrombie has found inflammation and suppuration of the brain a common attendant on paralysis*; concussion of the brain produces a suppression of its functions, without solution of continuity; and every tyro in medicine knows, that when it is not immediately fatal, inflammation is its most dangerous consequence. Excessive heat is well known to diminish the energy of the nervous system: hence it appears to be that coup de soleil

* Edinburgh Medical and Surgical Journal for January, 1819.

puts an instant stop to all the animal functions; and terminates in inflammation of the brain. Is it not, also, by the same mode of action that heat of climate produces so great a predisposition to inflammation? In tropical climates, the large intestines and liver are in a continual state of predisposition to put on inflammatory action*. Spirituous liquors, in their secondary effects, are known to debilitate and destroy the energy of the nervous system; and what a train of evils, of which inflammation is the basis, they draw after them! These may be attributed to their *stimulating* properties; but it is confessed that this portion of their effects is very transitory, and succeeded by an opposite class. It is during their debilitating or "sedative" effects that inflammation arises. It is not until the soldier has *got out of his jubilee* that he is attacked by hepatitis or dysentery: the stimulus which he continues to take, *prevents*, for a time, the inflammatory action, though it ensures its occurrence. Soldiers

* His Majesty's Royal Regiment was suffering dreadfully from dysentery at Wallajabad, in 1807, when they were ordered to the sea-coast for the recovery of their health. On the first day of this march they exhibited a most extraordinary instance of mortality. Sixty men (as I am informed on good authority) died in the course of the day, chiefly from coup de soleil and other affections of the brain, owing to the great heat of the weather, and their being imperfectly defended from it by small tents. It is evident that the general predisposition to disease which existed in the regiment was a great cause of this occurrence; for we constantly see regiments in a healthy state exposed to the greatest heat of the climate for long periods without a single case of coup de soleil happening. Epidemical attacks of dysentery, such as that which the regiment suffered from at the time, are usually produced by great heat. On this occasion the disease was attributed by the medical officers of the corps to that cause; and the greatest benefit was found from preventing exposure to the sun. We see, then, a certain degree of temperature producing an epidemic dysentery, or inflammation of the large intestines; and an increase of ten or fifteen degrees of that temperature (from living in tents), converting it in a great measure, into an epidemic apoplexy. Do not these circumstances argue a similarity in the *immediate* origin of these affections?

are so well aware of the effects of spirituous liquors in preventing disease for a time, that they constantly endeavour to get rid of pain in the side or bowels by drinking, previous to reporting themselves at the hospital.

Arsenic, lead, and various other poisons produce inflammation in the stomach and intestines similar to that of cholera; and Mr. Brodie has shown that this is not a mechanical or chemical effect on the coats of the viscera, nor from local irritation merely, for he found that it took place in even a greater degree from the insertion of poison into a wound, than from taking it into the stomach. It is a general opinion that poisons produce their effects by their agency on the nervous system; and the ingenious author just named has proved that many of them act by destroying the energy of the brain*. Can it then be denied, that diminution of nervous energy produces inflammation of the stomach and intestines?

Dr. Darwin observes, that "inflammation of a part is generally preceded by a torpor or quiescence of it†." He particularly mentions, that the inflammation of the stomach arising from gout is accompanied by torpor of that organ, and other marks of general want of action, as coldness of the extremities and debility of the circulation. Dr. Wilson Philip maintains that inflammation is owing to debility or paralysis of the capillaries, and consequent stagnation of blood in them; whence the arteries of the part are distended, and stimulated to increased action. This may afford some explanation of the great tendency to inflammation in cholera; for we may readily suppose the capillary vessels to be in that state, from the suppression of secretions which prevails at the same time, and the general debility and paralysis which characterize the disease.

Do not the inflammatory affections of cholera bear a perfect analogy, both as to nature and cause, with those which constantly occur in the stomach and intestines, or brain, in

* Med. and Surg. Journal for October 1812.

† Zoonomia, vol. i, p. 434.

the last stage of low, or nervous fevers? In these cases there exists much of that depression of all the powers of life which mark the last stages of cholera.

Inflammation appears to be the grand obstacle to recovery in a large proportion of the cases of this epidemic. In that state which I have termed its third stage, when the increased actions in general have ceased, and the circulation is reduced to extreme debility, favourable symptoms will frequently arise: the general warmth of the body and some of the secretions will re-appear; but the small portion of returning life appears to be exhausted in morbid exertions of strength in the smaller arteries, producing such organic changes as are incompatible with the continuance of life. This is particularly the case in the European habit, which is evidently more predisposed to inflammation than that of the Native (a circumstance which appears to arise from intemperance); for it has been generally remarked, that Natives very frequently recover after the pulse has disappeared from the wrist, but Europeans scarcely ever.

SECT. V.

OF THE AFFECTIONS OF RESPIRATION AND THE CHANGES OF THE BLOOD.

In this inquiry we have hitherto seen the nervous system in no other light than that of a sovereign power, exerting an unbounded influence on the other organs, and holding them in immediate and entire dependence. From this limited view of the subject we should be led to consider that system as the grand *primum mobile* of the animal frame, itself independent: but this is by no means its true character. The nervous system itself is immediately dependent on the heart for a supply of arterial blood, without which its healthy energies cannot be exerted for an instant.

This *mutual* dependence of organs constitutes a very remarkable difference between animate and inanimate mechanism; for, until the perpetual motion shall be discovered, we shall find nothing in the latter which bears the remotest analogy to the circle of movement which is displayed by the former. The main-spring of a watch, like the nervous system, holds the inferior parts of the machine in dependence on it; but it does not, like the nervous system, receive an accession of power from the impulse which itself gives rise to. The mechanism of a watch may be strictly compared to *a line*, the beginning of which is the main-spring, and the end the hands; the animal mechanism resembles *a circle*, which has neither beginning nor end.

The dependence of the functions of the brain on a supply of blood is an established point in physiology. It is proved by syncope taking place from bleeding and the change to the erect posture, and by the fact of tying the vertebral arteries instantly producing asphyxia. Bichat has farther shown, that it is not from want of blood alone, but from want of arterial blood, that these phenomena arise; for on turning the stream of blood from the jugular vein of a dog into its carotid artery, the same effect was produced. Yet the carotid arteries of two dogs were made to communicate with each other by means of a tube, in consequence of which the heart of one conveyed *arterial* blood to the brain of the other, without any bad effect being produced in the animal which received the blood, so long as repletion was avoided by an open vein in another part of the body. The only inference that can be drawn from these facts is, that the change of the blood which usually takes place in the lungs is immediately necessary to the action of the brain; and *as we have proof that this change is imperfectly performed in cholera, it becomes extremely probable that this is the cause of the diminished energy of the nervous system, which produces the other phenomena of the disease.*

Previous to adopting this important conclusion, it is ne-

cessary to inquire, whether the unnatural state of the blood in cholera is a primary affection; or only an effect, and not the original cause, of the morbid condition of the whole system.

A deficiency of the change from venous to arterial blood may take place in four different ways. 1. From a deficient action of the muscles of respiration, in consequence of which a sufficient *quantity* of atmospheric air is not introduced into the lungs: or in other words, from an interruption to the *mechanical* part of the function of respiration. 2. From a deficiency in the quantity of blood which is transmitted through the lungs. 3. From a deficiency in the respired air of those principles which are necessary to the change of the blood. 4. From a morbid state of the lungs or the blood, by which they are rendered incapable of acting on the air, so as to produce the requisite change in the blood. It is a circumstance which adds extremely to the difficulty and obscurity of this part of the subject, that there should be some reason to believe that each of these causes is present in cholera.

The first of them, however, will not detain us long; for though the action of the muscles of respiration depends upon the brain, and on the supposition that that organ is acting with diminished energy, we should expect that their functions would be performed with diminished force; yet we have the evidence of our senses to convince us that there is no deficiency in the quantity of the air taken into the lungs; on the contrary, we see the respiration hurried, which convinces us that an unusual quantity must be taken in. And, as the muscles of respiration are under the influence of the will, we must expect that that power will be exerted, as long as it remains, to supply any deficiency of air in the lungs.

It cannot be denied that a weak action of the heart must give rise to a diminished circulation of blood through the lungs, and consequently tend to obstruct the process alluded to, and that a total cessation of its action must necessarily put a stop to the chemical phenomena of respiration; but this weak action alone appears to be incapable of producing the

effect, in the degree in which we find it in cholera; for if we admit that belief, we must expect to find that symptom in all cases of syncope, and even in every instance in which the action of the heart is greatly weakened; which is not the case. On the contrary, it is a very remarkable, but unexplained fact, of every day occurrence, that, when syncope takes place in bleeding, the blood which flows from the arm becomes of a more florid colour. It is, however, well known, that arterial blood by stagnating in any part, even in an artery, assumes the dark colour. Hence it is probable that this cause has a share in producing the remarkable appearance of the blood in cholera; but I have distinctly observed it, in at least one instance, when the force and quickness of the circulation were much increased.

The lungs themselves are supplied with nerves, from whence it may be inferred that nervous influence is in some way necessary to their action; and as it has been presumed that a general deficiency of nervous influence exists in cholera, that supposition appears sufficient to account for this phenomenon. We here experience that difficulty which is so frequently felt in distinguishing causes from effects in the *circle* of animal movements, and which has occasioned so many of the latter to be classed amongst the former;—which has made the superabundance of bile according to one hypothesis, and the deficiency of it according to another, in their turns be considered the proximate cause of cholera!* The great question at present appears to be; is the deficient change of the blood in the lungs the *effect* or the *cause* of the diminished energy of the nervous system? Does it arise, in the first instance, *ab externo* or *ab interno?* On one hand

* Agreeably to each of these theories, we find the practitioner in Europe using all his efforts to dilute and *evacuate* the peccant bile in this disease; and the practitioner in India actually *pouring it in*, from the gall-bladder of the sheep or the bullock! The latter practice has been extensively employed and warmly recommended by a surgeon of this Establishment.

it may be argued, that nervous influence is not immediately necessary to the oxygenation of the blood. Mr. Brodie has drawn this inference from observing that it went on in the lungs after the brain was removed; and we have this striking fact in support of it, that the process goes on without the body as well as within the lungs. On the other hand, it is evident that a faulty state of the atmosphere alone is insufficient to account for the phenomena; for if it could even be proved that a deficiency of oxygen existed in the atmosphere during the prevalence of cholera, it would still be necessary to suppose some internal cause combining to produce the morbid condition of the blood in those who were attacked, or preventing it in those who escaped, else it should appear alike in all. Farther evidence of facts is necessary to extricate us from this maze of theory. If it shall appear that the atmosphere during the prevalence of the disease, actually is in such a state as to tend to prevent the due performance of the function of respiration, from its wanting the due proportion of a principle necessary for that process, it will be sufficient to turn the scale of our belief; and to give the impediment to that function the rank of the original cause. In that part of the work which treats of the remote causes of the disease, this branch of the subject shall be resumed; an attempt will be made to prove the existence and nature of such a cause; and the manner in which it produces the proximate cause of the disease. If I shall not have succeeded in these undertakings, their magnitude and difficulty, though they place my temerity in too strong a light, may well excuse my failure.

CHAP. V.

OF THE RELATIONS OF CHOLERA TO OTHER DISEASES.

SECT. I.

TO THE SWEATING SICKNESS.

It appears extremely probable, that the epidemic which has committed so much devastation throughout India, has already prevailed to an equally general and fatal degree in England, and many parts of the continent of Europe, under the name of the *sweating sickness*. That singular disease was never known but as an epidemic of the most general prevalence, and usually of the most malignant nature. It is said to have never been heard of in the world but for a few short periods included between the years 1483 and 1551. It never appeared except in summer. It was usually fatal in from one to twenty-four hours from its attack. In addition to these peculiarities, it has presented a numerous and striking set of symptoms, which are rarely found in an equal degree singly, and perhaps never in combination, in any other disorder. Hence it has ever stood alone in the annals of disease, as one to which no parallel could be found either in preceding or following ages: it will, however, appear, that the epidemic cholera exhibits all these symptoms in the highest degree, and that many of them are amongst its most striking and characteristic appearances.

I have not, indeed, met with any original work on that disease, for it is probable that few of them are now in exist-

ence; but the short notices of it which have been transcribed from these authors, and are given in systematic works and books of reference, afford striking proofs of its identity with the Indian epidemic. To enable the reader to form his own judgment, I will present them almost entire.

The disease has received numerous synonyms, the principal of which are, *sudor anglicanus*, and *ephemera maligna sudatoria*. It first appeared in the army of Henry VII, on his landing at Milford Haven in Wales, in 1483. The best authorities seem to agree that it did not on this occasion extend to London. Its next attack was in 1485; and it is singular that at this distance of time, the *days* of its appearance and abatement or cessation should be preserved; a circumstance which proves that these events were very sudden. It broke out with extreme violence in London, on the 21st of September; and "stopt all at once" on about the 12th of October (other accounts, however, say towards the end of that month). It is also said that it extended all over England on the same day that it appeared at London; and that it swept off in a short time one-third of the whole population; but these statements must be received with great limitation. It returned in 1506, and again in 1517 and 1518, when it was commonly fatal in three hours; numbers of the nobility, and in many towns half the common people being carried off. It returned again in 1528. It then proved fatal in six hours. King Henry himself narrowly escaped from it, and most of his courtiers suffered. It appeared for the fifth and last time in 1551; when, also, it was extremely fatal. Caius, who has written on the subject, reports that the country in the neighbourhood of Shrewsbury, where he resided, was on this occasion nearly depopulated. At the same time it spread itself over a great part of the continent of Europe, where it was equally fatal. It was then witnessed by Erasmus, who describes the horrors which attended it in very forcible terms, which might be well applied to the epidemic cholera. "Visum est," he says, "ex amne Phlegetoneo emissum hoc malum."

The following description of it is found in Parr's and Motherby's Medical Dictionaries. "The disorder attacks with a pain in the neck, scapula, legs, or arms, and sometimes a kind of warm vapour, or flatulence only, ran through these parts, succeeded by a profuse sweat, for which the patients could not account. The internal parts next became warm, and were soon seized with an incredible heat, which afterwards diffused itself to the extremities; an intolerable thirst, restlessness, sickness, and indisposition of the heart, liver, and stomach (langueur d'estomac, vomissemens, maux de cœur—*Dictionnaire Raisonné*), were the next symptoms; succeeded by headach, delirium, excessive debility, a kind of extenuation of the body, and an irresistible necessity for sleeping. The sweat was of a disagreeable smell, coloured, and it is said of an unusual consistence. Some were seized with nausea, others with vomiting; all without exception with difficulty of breathing. The urine was of a thicker consistence, and fainter colour than natural. The pulse was rather quicker than natural. Those who breathed the purest air, and had the best constitutions, escaped the most easily.

"The disease was undoubtedly an ephemera of the most asthenic kind; and, if we can discern the truth in the heterogeneous mixture of fable which arose from the terror this fever excited, there will be little doubt of its having arisen from specific contagion, which at last lost its effect from the constitution being habituated to it. The records of medicine offer nothing analogous, 'nihil simile aut secundum,' except the extension of the epidemic to the continent within the period assigned."

In Rees's Cyclopedia a somewhat more precise account is given: — "The invasion of the disease was extremely sudden, and was marked by the affection of some particular part, producing the sensation of intense heat, extending through the limb, and afterwards diffusing itself through the body. This was generally followed by profuse sweating, which continued more or less through the whole course of the disease, and was

attended with insatiable thirst. Extreme restlessness, headach, delirium, nausea, cardialgia, and an irresistible tendency to sleep, characterized its progress, together with great prostration of strength, producing frequent fainting, and irregularity in the action of the heart, which sometimes palpitated violently, whilst at other times the pulse was weak and fluttering. In this way the patient was carried off, frequently in one, two, or three hours, after the eruption of the sweat. Those more especially who bore their sufferings with impatience, or who sought relief from the *sense* of heat, by which they were tormented, by exposing their bodies to the air, or even by putting their arms out of bed, were often suddenly struck by death. The sweat, when promoted, is represented as being unusually clammy, and having a very strong and peculiarly fetid odour. The violence of the attack was over in fifteen hours, but the patient was not out of danger till the expiration of twenty-four hours.

"It appeared always in summer, and continued from three to five months. The most general opinion at the time certainly appears to have been, that it arose from some peculiar state of the atmosphere, and was propagated by contagion.

"From the description which Weirus has given us of the epidemic as it appeared in Germany, it seems to have commenced with a violent cold stage and shivering, which continued half an hour or more, accompanied with great pain in the region of the diaphragm and groin, and other symptoms already mentioned as characterizing the disease when observed in England. Swelling and stiffness of the hands and feet at the beginning of the attack, and vomiting of black blood or bile, are also noticed by this author in particular *."

In Dr. Mead's work on the plague, I find a very short account of the disease, consisting of little more than the following brief enumeration of its symptoms. "Excessive faint-

* Article, *Sweating Sickness.*

ness and inquietude, inward burnings, headach, sweating, vomiting, and diarrhœa."

The attack of the disease, as described by Burserius, presents farther points of identity with cholera. "It begins with great loss of strength and fainting. It is sometimes preceded by great shaking and horror, and is followed by acrid moisture of the skin, which shortly becomes a very profuse and continued sweat, frequently ceasing only with the extinction of life, most commonly within twenty-four hours. There is almost always present unusual internal heat, unquenchable thirst, great fear and despair, extreme anxiety about the præcordia, an affection of the stomach like cardialgia, and pain in the loins *." The remainder of his description does not differ materially from the statements already given.

Other accounts say:—"The disease attacked different persons in different ways. Some were seized abroad, and cut off in the road; others when fast asleep. Some died in a moment; others in one, two, three, or four hours after they began to sweat." It is generally described as a very dangerous disease; and it is particularly remarked, that at the beginning of any of its attacks very few recovered from it. Such has been decidedly the case with the severe visitations of the epidemic cholera. The early cases are almost all of the low, asthenic form, and very few recover, after which a sort of crisis occurs, and the cases become mild and easily manageable. It is even not uncommon for *the whole* of the cases which occur in particular hospitals to terminate fatally until the change in the causes takes place; after which, they *all* recover. This happened in the General Hospital of Madras in 1818; and (with scarcely any exception) in Mr. Curtis's practice, in 1782, see page 21 of this work. The sweating sickness has also been a much less virulent disease on some occasions than usual; for it is recorded, that, in one instance,

* Brown's Translation of Burserius, vol. i, p. 393.

out of 20,000 attacked with it not more than 2000 died — a small proportion, considering the imperfect state of medicine in the age in which it prevailed.

The disease appears also to have had various sequelæ resembling those of cholera. Burserius remarks: — "Those in whom the sweats do not flow long, either die immediately, or are brought into imminent danger by the supervening of a very bad fever." Again: — "Frequently during several months the patients are wasted with night sweats." This was probably owing to hectic fever, from suppuration of the liver or some other viscus. The Dictionnnaire Raisonné informs us, that many of those who escaped the first attack were carried off by a "cours de ventre" — in all probability, dysentery.

The disease has usually been classed with the kind of fever called *ephemera*; probably from the single circumstance of its short duration; for it differs from the single and slight paroxysm of fever which has given rise to that term, perhaps as widely as any two diseases can differ from each other. It is nowhere distinctly expressed, as far as I can learn, that it was attended by actual heat of the surface. All accounts agree that there was an extreme *sense* of heat, particularly in the stomach and bowels; but we constantly witness this in cholera, extending even over the whole frame, when it is far below the natural temperature. Burserius, in proof of the febrile nature of the disease, adduces only the state of the pulse and respiration: — "Even from the beginning, the quickness, frequency, and inequality of the pulse, indicate the presence of fever; sometimes the pulse becomes strong and violent; the breathing is quick and broken." Mead considered it as a species of plague; but it was evidently free from the usual diagnostic symptoms of that disease; for Burserius says, "hæmorrhages seldom occur; and no one labouring under this disease is liable to buboes or eruptions."

Many of the opinions which have been handed down to us regarding the cause of this epidemic, partake of the supersti-

tion of the age in which they were formed. It is said that the English alone were attacked; that it followed them wherever they went, and left untouched persons of other nations who resided in England. And it is seriously alleged by many, particularly foreign writers, that it was an immediate dispensation of Providence, as a punishment to the nation, for their incredulity in matters of religion. Some valuable observations of a physical nature, regarding its origin, have, however, been preserved; and probably many more will be found in the original writers on the subject. Great changes in the seasons were observed about the times of its prevalence, and unusual dampness of the atmosphere was found to attend it. It has also been ascribed to planetary influence; and perhaps with less improbability than the prevailing opinions of the present day will admit. The Dictionnaire Raisonné informs us, that Schiller attributes the disease to this cause; and adds, that "the great changes of the seasons and bad quality of the air have contributed to produce it; and alleges in proof of this, that it was observed that great numbers of birds were found dead under the trees at the time when it prevailed. It is not to be doubted that the bad qualities of the air are the cause of all epidemics, and consequently of the sweating sickness; but why did they not produce that disease before the year 1483? This question might have been answered, if the persons who have written on the subject had been better physicians and observers*."

Burserius says:—"In general, it prevails epidemically in some district, after damp hazy weather, especially in summer or autumn. It is extremely probable that the cause is a very subtile and deleterious poison, contained in the air, whencesoever it is generated, or supplied by the putrid effluvia proceeding from the earth; which is rendered probable by the

* Article, *Sueur Angloise.*

state of weather preceding the disease, and the quantity of birds found dead at the time, with abscesses of the size of vetches under their wings."

It was also believed to be propagated by contagion; but its sudden and repeated appearance and disappearance are adverse to that opinion, and at least prove that that was far from being its sole cause. The most determined advocate for contagion cannot suppose that it is capable of spreading a disease over a large city, much less a whole country, in a day. Dr. Willan, from an analogy which he has found between this disease and a very fatal epidemic termed Feu Sacré, Feu de St. Antoine, and Mal des Ardens, supposed to arise from the use of ergoted rye as food, has conjectured that it was owing to some disease or depravation of the wheat, or to some noxious vegetable growing with it; without, however, adducing any evidence that such was the case; and the opinion has been very successfully combated in a paper in the 4th volume of the Edinburgh Medical and Surgical Journal.

We have another description of this disease which is calculated to preserve its memory to the most distant ages, even if it shall continue unknown in reality. Armstrong has shown, that medicine is capable of being clothed in the brightest flowers of poetry; and this is perhaps nowhere so strongly exemplified as in the picture which he has drawn of the English plague.

> "The all-surrounding heaven, the vital air,
> Is big with death. And tho' the putrid south
> Be shut; tho' no convulsive agony
> Shake, from the deep foundations of the world,
> Th' imprison'd plagues; a secret venom oft
> Corrupts the air, the water, and the land.
> What livid deaths has sad Byzantium seen!
> How oft has Cairo, with a mother's woe,
> Wept o'er her slaughter'd sons and lonely streets;
> Even Albion, girt with less malignant skies,
> Albion the poison of the gods has drank,
> And felt the sting of monsters all her own.

Ere yet the fell Plantagenets had spent
Their ancient rage at Bosworth's purple field;
While, for which tyrant England should receive,
Her legions in incestuous murders mix'd,
And daily horrors, till the Fates were drunk
With kindred blood by kindred hands profus'd;—
Another plague of more gigantic arm
Arose, a monster never known before,
Rear'd from Cocytus its portentous head.
This rapid fury, not, like other pests,
Pursu'd a gradual course, but in a day
Rush'd as a storm o'er half th' astonish'd isle,
And strew'd with sudden carcasses the land.
First thro' the shoulders, or whatever part
Was seiz'd the first, a fervid vapour sprung.
With rash combustion thence, the quivering spark
Shot to the heart, and kindled all within;
And soon the surface caught the spreading fires.
Thro' all the yielding pores, the melted blood
Gush'd out in smoky sweats; but nought assuag'd
The torrid heat within, nor aught reliev'd
The stomach's anguish. With incessant toil,
Desperate of ease, impatient of their pain,
They toss'd from side to side. In vain the stream
Ran full and clear, they burnt and thirsted still.
The restless arteries with rapid blood
Beat strong and frequent. Thick and pantingly
The breath was fetch'd, and with huge lab'rings heav'd.
At last a heavy pain oppress'd the head,
A wild delirium came; their weeping friends
Were strangers now, and this no home of theirs.
Harrass'd with toil on toil, the sinking powers
Lay prostrate and o'erthrown; a ponderous sleep
Wrapt all the senses up: they slept and died.
In some a gentle horror crept at first
O'er all the limbs: the sluices of the skin
Withheld their moisture, till by art provok'd
The sweats o'erflowed; but in a clammy tide:
Now free and copious, now restrain'd and slow;
Of tinctures various, as the temperature
Had mix'd the blood; and rank with fetid steams:
As if the pent-up humours by delay

Were grown more fell, more putrid and malign.
Here lay their hopes (tho' little hope remain'd)
With full effusion of perpetual sweats
To drive the venom out. And here the Fates
Were kind, that long they linger'd not in pain.
For who surviv'd the sun's diurnal race
Rose from the dreary gates of hell redeem'd:
Some the sixth hour oppress'd, and some the third.
Of many thousands few untainted 'scap'd:
Of those infected fewer 'scap'd alive;
Of those who liv'd, some felt a second blow;
And whom the second spar'd, a third destroy'd.
Frantic with fear, they sought by flight to shun
The fierce contagion. O'er the mournful land
Th' infected city pour'd her hurrying swarms:
Rous'd by the flames that fir'd her seats around,
Th' infected country rush'd into the town.
Some, sad at home, and in the desert some,
Abjur'd the fatal commerce of mankind:
In vain: where'er they fled, the Fates pursu'd.
Others, with hopes more specious, cross'd the main,
To seek protection in far distant skies;
But none they found. It seem'd the general air,
From pole to pole, from Atlas to the East,
Was then at enmity with English blood.
For, but the race of England, all were safe
In foreign climes; nor did this Fury taste
The foreign blood which England then contain'd.
Where should they fly? The circumambient heaven
Involv'd them still: and every breeze was bane.
Where find relief? The salutary art
Was mute; and, startled at the new disease,
In fearful whispers hopeless omens gave.
To Heaven with suppliant rites they sent their pray'rs;
Heav'n heard them not. Of every hope deprived;
Fatigu'd with vain resources; and subdued
With woes resistless and enfeebling fear;
Passive they sunk beneath the weighty blow.
Nothing but lamentable sounds was heard,
Nor aught was seen but ghastly views of death.
Infectious horror ran from face to face,
And pale despair. 'Twas all the business then

To tend the sick, and in their turns to die.
In heaps they fell: and oft one bed, they say,
The sick'ning, dying, and the dead contain'd.
Ye guardian Gods, on whom the fates depend
Of tottering Albion! ye eternal Fires
That lead thro' heav'n the wandering year! ye Powers
That o'er th' encircling elements preside!
May nothing worse than what this age has seen
Arrive! Enough abroad, enough at home
Has thinn'd her cities; from those lofty cliffs
That awe proud Gaul, to Thule's wintry reign;
While in the West, beyond th' Atlantic foam,
Her bravest sons, keen for the fight, have dy'd
The death of cowards and of common men:
Sunk void of wounds, and fall'n without renown."

Time has in a great measure covered with oblivion the horrors which this mammoth of diseases has produced; for, like its prototype in the animal creation, it has long been recognized only in its surprising remains; but it would seem that its race is not extinct, and that it has again made its appearance in its most hideous shape, on the plains of Hindostan. Heaven forbid that England should ever again contemplate it but at a distance!

If, however, it shall be proved that these epidemics are the same, it will show that the situation of Europe is no defence against its attacks, even in its very worst form; hence the question becomes peculiarly interesting, and I cannot consider any apology necessary for taking a nearer survey of it.

The greatest of the objections which can be made to the opinion of their identity is, that in the above accounts of the sweating sickness, *spasms* are nowhere mentioned: but from the imperfect descriptions of the disease which have been handed down to us through so great a period of time, and particularly from the imperfect transcripts of them which I have obtained, it is not strictly to be inferred that this symptom did not exist. We know that the disease was considered as a fever, and it is therefore not improbable that a

symptom which made against that opinion, may, in these dark times, have been wilfully overlooked. Admitting, however, that it was not present, that fact would not disprove the identity; for in a vast number of instances we have seen the worst forms of cholera without any appearance of spasm, and this not in casual cases, but in nearly the whole of a large number of its attacks at particular places*. It is, however, exceedingly probable that spasms will be found to be mentioned by the original writers on the sweating sickness. The *stiffness* of the hands and feet noticed by Weirus may have arisen from the tonic spasm.

It must also be remarked, that vomiting and purging, and particularly the latter (though both have clearly been present in the disease), do not appear from these accounts to have been among the most prominent symptoms of the sweating sickness; but to this objection precisely the same arguments will apply as have been opposed to that of the absence of spasm; and when we find an author (Dr. Girdlestone) writing an express treatise on the Indian epidemic, without making the smallest mention of purging, we cannot consider that symptom as any ground of diagnosis.

The "strong and vehement pulse," the "restless arteries," and the "*smoky* sweats," of Armstrong, must be looked upon chiefly as poetical embellishments; for on other occasions, where accuracy and not sound has been studied, it is recorded that the pulse *sometimes* beat strong and violent, the heart *sometimes* palpitated violently, but all agree that the utmost prostration of strength usually attended the disease; and in their having omitted to mention actual heat of the surface, when in search of arguments to prove the presence of fever, we have a negative argument against the existence of that symptom, nearly as strong as any of the most positive description can be. The excessive and uncritical sweats which marked this disease, are sufficient to show that it was not a

* See extracts from Mr. Conran's and Mr. Duncan's Reports, p. 29, 30.

fever; for in no fever with which we are acquainted does copious and general perspiration commonly occur without a remission or removal of the disease.

The prevalence of the humoral pathology at the time, and the idea that the morbific matter was carried off by the perspirations, have probably occasioned the great and almost exclusive attention to the symptom which has given rise to the name of the disease. But this is also a constant and very remarkable symptom of cholera; and the sweat is not "forced out by violence of the spasms," for it occurs in equal profusion where no spasms are present.

The particular mention which is made of the disease attacking first some extremity or member, and extending from thence to the internal parts of the frame, is probably another consequence of the mistaken ideas of the times, for they seem to have considered that the morbific matter made its entrance in that way. We observe, however, something similar to this in the numbness and pain which is frequently observed as attacking the extremities in the beginning of cholera; and the sensation described by the Tassildar* (whose opinions of the disease probably bore a strong analogy to those of our ancestors), affords a remarkable parallel to the "sense of warm vapour" running up from the extremities in the sweating sickness. This affection appears to be the same with the *aura epileptica;* and affords another presumption that the disease was of a nervous and spasmodic nature.

The *internal burning* was evidently one of the most remarkable symptoms of the sweating sickness; and from the term cardialgia (heart-burn) which has been applied to it, we learn that its principal seat was the stomach. In fact this symptom, the excessive thirst, and the sudden and extreme debility, anxiety, and depression of spirits, are all so peculiar, so constant, and so strongly marked in both these epidemics, as almost alone to prove their identity. Oppression and dif-

* See page 37.

ficulty of breathing is another marked symptom common to both. The "irresistible necessity for sleeping" *in the advanced stages*, is not more evident in one than the other. The headach and delirium of the sweating sickness are in proof of inflammation of the brain, a well-known consequence of cholera. The pale urine, the *clammy* sweat, the *pain* and oppression about the præcordia, the intolerance of the bedclothes, the "extenuation of the body," in short, every symptom in the above descriptions of the sweating sickness, indicates its identity with cholera. The smell arising from the body in the disease, which is said to be "puant à merveilles," also finds a remarkable parallel in the peculiar odour which has been constantly observed in cholera *.

It is likewise worthy of observation how remarkably these epidemics have coincided in many other circumstances. Their duration was equally short; for cholera has generally been found to come to a crisis, or terminate, either favourably or unfavourably, in less than twenty-four hours from the attack. They have both appeared very suddenly, and after prevailing with excessive violence for a short time at a place, have as suddenly abated or disappeared. They have each been attributed by one class of persons to the use of bad corn, by another class to contagion; but the most received opinions regarding both refer them chiefly to some unusual state of the atmosphere. From the extraordinary features, which both have exhibited, when they appeared in their violent epidemic form, each of them has been considered as a disease perfectly *new* and *sui generis*.

In a curious old volume (dated 1614), which I have met with, an account is given of the sweating sickness, which carries this resemblance still farther. The morbific cause is almost personified, and represented as an unique and indivisible agent, moving about from place to place, and appearing in one part of a country as it quitted another. "After having

* It is observed, that when the blood is not duly arterialized, owing to bronchitis, it has an unpleasant smell, like that of bugs. Does the odour of cholera arise from this cause?

committed terrible ravages in England, *the Sweat* left that country, and visited Norway, Denmark, and Poland; passing from province to province and from city to city (se faisant connoitre de province en province, et de ville en ville). It afterwards extended itself over nearly the whole of Germany, and passed the Rhine; not omitting on its departure from Poland, to visit the cities on the Baltic sea, Dantzic, Lubec, Hamburg, and Bremen. Having at length reached Cologne, it traversed, like a courier, the provinces of Juilliers and Liege; from thence it passed into Brabant, Flanders, and Overyssel, and the country around Utrecht; and reached Amsterdam on the 27th of September 1529; from that place, carried in a thick mist, which served it as a vehicle (en carosse), it passed into Zealand; and being driven from thence, it returned to England, where it lodged and remained for several years*."

Much of this, doubtless, consists of fable and exaggeration; but who, that has witnessed the epidemic cholera, can forbear comparing this account with the gradual and progressive, though often desultory manner, in which it has extended itself over India?

In the treatment, their principal endeavours were directed to promote the perspiration and to support the strength, consequently they covered up the patient, to his excessive annoyance, with great quantities of blankets; and to such an extent was this carried, that many are said to have been actually suffocated. Notwithstanding the extreme thirst, they withheld drink entirely in the early stages; and when given, it was of a stimulating kind—ale or wine, and other cordials, with various kinds of spices and aromatics. They employed warm frictions. Bleeding is said to have been found injurious, and forbidden. As a preventive measure, crude potherbs and salads were ordered to be avoided.

Thus, even in the treatment which has been adopted in both these epidemics we find a remarkable coincidence.

* Histoires admirables et memorabiles, recueillés par Simon Goulart.

Covering up the patient with several blankets, and exciting copious perspiration by means of the vapour-bath (though not employed with the view of expelling morbific matter through the skin), have been very generally employed in cholera, and attended with the best effects. Stimulants of various kinds have been urgently indicated by the extreme debility, and constantly employed in both. Warm and stimulating frictions have also been much employed in cholera. Indulgence in cold water, to the extent which the desire for it demands, has frequently been found to be attended with fatal effects, in the Indian as well as the English disease; and accordingly, drink has been in a great measure prohibited in both. "Crude pot-herbs and salads" are a well-known exciting cause of cholera *.

* It is a curious coincidence, that the resemblance between the epidemic cholera and the sweating sickness should have been pointed out to me by my brother, Mr. James Orton, Surgeon of the Bombay Establishment, by letter, at the same time that I suggested it in that manner to him—the letters containing these communications passing each other on their way. In many other instances as well as in this, I am indebted to him for much essential assistance in this work.

Note to the Second Edition.—Admitting that there are some features of difference between the sweating sickness and cholera, there is still the highest probability that one is but a modification of the other. We have seen cholera prevailing in various forms, not only in individual attacks, but in general visitations; and we are doubtless yet unacquainted with all these varieties. One, if not two more of them appear to be brought to light by Mr. Scot's valuable work on cholera, in an account which appears in it of an "endemial causus" which prevailed at Ellore in India, in May and June 1794. It prevailed in two forms; the first resembled apoplexy, but less sudden in the attack, and was attended with great disorder of the stomach, heat of the surface, and very rapid pulse. It was usually fatal in three hours. The other greatly resembled the most violent form of remittent fever, but was more sudden in its onset and rapid in its progress, and had the most distinctive symptoms of cholera superadded, as vomiting, pain at the stomach, and intense thirst, spasms in the intestines and muscles of the limbs, &c.

Dr. Good finds cholera arising from malaria, and doubts that it is an

SECT. II.

OF THE RELATIONS OF CHOLERA TO SOME OTHER EPIDEMICS.

It will probably be found that some other epidemics, which have received the names of plague and pestilential fever, have been no other than cholera, in some of its various forms. Burserius classes the sweating sickness under the head of *ephemera maligna*, and in the same place he gives an account of "a species of malignant ephemera, which suddenly arose from a pestilential miasma or contagion, accompanied with uncommonly terrible symptoms, and which was extremely fatal to the soldiery." He informs us that it was communicated to him by Reinlien, professor of physic, and physician in ordinary to the military hospital in Vienna. No date is affixed, but it appears to have occurred during the latter half of the eighteenth century. "Many were attacked at the same time; their faces became of a bluish yellow; their eyes were like those of a person half dead, sunk in the sockets; their nose and forehead became sharp, and their skin rigid; their superior and inferior extremities were at first pale, a little after they became cold, and successively livid and black; the pulse was very weak; the respiration extremely anxious, there was a constant vomiting of a green rust-coloured and fetid matter; the tongue was moist, tremulous, and foul; some thirst; the belly bound; and when excited by injections, green cadaverous stools took place; the hypochondres were tense, and there was a great dejection of spirits. Towards the end of the third, fourth, and even sixth day, during the greatest anxiety and frequent fainting, death came on.

"A surgeon's daughter, of about sixteen years of age, strong and healthy, frequently used to enter the place where the bodies were kept until they were interred. One day, as

essentially different form of morbid action from fever. This causus, as well as the sweating sickness, may be some of the lost links which connect these two great types of disease.

she was returning from this place, she was suddenly seized, as it were, with intoxication; and on arriving at her chamber she immediately became first cold, then hot, with a febrile pulse, and began to vomit a greenish rust-coloured matter; and shortly afterwards she became speechless, and was attacked, first with slight, then enormous, convulsions over the whole body. Whatever was put into her mouth she either did not swallow, or rejected it, likewise injections immediately came off. The blood when drawn showed no faulty condition, except unusual density. Twenty-four hours afterwards I was called in, when she had altogether the cadaverous appearance. The pulse was scarcely perceptible, her lower jaw was affected with tetanus, there were constant convulsions, and involuntary stools, emitting a cadaverous smell. The means employed were all to no purpose; and she expired on the thirty-sixth hour from the commencement of the complaint.

"To this malignant ephemera may be referred the first kind of pestilential disorder that occasioned such havoc at Marseilles in the year 1720; arising from a very noxious and deadly contagion. The persons affected with it were affected with inordinate shivering, accompanied with a small, soft, slow pulse, or a quick, irregular, contracted, or depressed one. But such was the heaviness of the head that patients could scarcely raise it, at the same time becoming stupefied and confused, as if they had been intoxicated. Their downcast looks, and the dulness of their eyes, indicated their terror and despondency. Moreover they spoke with a slow, abrupt, and querulous voice. Their tongue was almost always white, at last it became dry and reddish. Their face was pale, lead-coloured, thin, cadaverous. There were very frequent fainting fits, extreme anxiety and prostration of strength, deep sleep, nausea, and vomiting. Those who were thus affected were generally carried off in the space of a few hours, or one night or day, or at farthest in two or three days; their strength being reduced to the lowest possible ebb, or sinking under

the violence of tremors or convulsive motions, without any external tumour or eruption appearing *."

In these instances we observe the mark of similarity to cholera which was wanting in the sweating sickness — spasms; for in each of these relations convulsions are mentioned, and in that of the surgeon's daughter it is evident that the tonic spasm was present. In fact it can scarcely be doubted that her's was a case of pure and perfect cholera; and as far as the above account of the celebrated plague of Marseilles goes, it corresponds in a great measure to the Indian epidemic. In all these affections, as well as in the sweating sickness, we have the important distinction from plague which arises from the absence of buboes or carbuncles.

It is, however, well ascertained, that the disease which prevailed at Marseilles on the occasion here alluded to, was chiefly the true or inguinal plague. It is not improbable that cholera has also prevailed there at the same time or immediately previous, and from the same causes; for in innumerable instances in India we have seen the great cause of this epidemic appearing to produce various other diseases; and on one occasion the plague itself is ascertained to have appeared in India, for the first time on record, during the late prevalence of cholera.

It is also highly worthy of inquiry how far the fatal epidemic called *Feu Sacre*, *Feu de St. Antoine*, and *Ergot*, which at different periods has prevailed extensively in Europe, particularly at Sologne in 1650, partakes of the nature of cholera. From the bare circumstance of the sweating sickness having been attributed by Dr. Willan to the same cause with that disease (injured corn), it is probable that a strong analogy exists between them; and it is particularly remarked that the latter was attended with spasms. It does not appear to be at

* "Muratori, Relazion della peste di Marsiglia, p. 4. Likewise the description given by the physicians of Montpellier, Chicoyneau, Verny, and Souillier."

all established that the ergot was produced by any poisonous principle in the corn, for it is strenuously denied by authors who have witnessed the disease; and Dr. Bateman observes, "There is every reason to believe that the epidemic was the result of starvation or deficient nutriment, and not diseased corn. Cumerarius observes, that the gangrene was observed in the extremities of persons who had certainly not eaten any ergoted rye. It appears, however, that another disease of a febrile and contagious nature, but essentially different from the plague and common typhus, and which was frequently epidemic during the times of dearth in various parts of Europe during the fifteenth, sixteenth, and seventeenth centuries, has also been called ignis sacer, &c., and ascribed to the ergot in rye, or to the mixture of other unwholesome plants, such as the raphania, with the food. The disease is said to have begun with an intense heat, accompanied with a sense of formication, or of the creeping of insects, over the skin; which was followed by acute pains in the limbs and general convulsions of the muscles, by which the patient was often carried off*.

It has been remarked, that the diseased state of the corn and the epidemic attributed to it, occurred in unusually moist and rainy seasons; the same circumstances attended the sweating sickness; and it will subsequently be shown, in the clearest manner, that similar states of the atmosphere have marked the periods in which the epidemic cholera has prevailed: it is therefore at least as probable that both the ergot and ignis sacer — the diseases both of the animal and vegetable creation — have been effects of a common cause, as that they have actually stood in the relation of cause and effect to each other. Webster has shown, that diseases, not only of inferior animals but of plants, have very commonly attended epidemics.

It must, however, be observed, that there is a striking

* Bateman on Contagious Fever in England, 1818. For further accounts the articles Ergot and Ignis Sacer in Rees's Cyclopædia are referred to.

difference between the ergot, as it is commonly described, and the epidemic cholera, in the dry gangrene which accompanies the former; for in no instance have I heard of that occurrence as a consequence of the latter. But, after the infinite variety of forms which we have seen cholera assuming in India, we can scarcely look upon any single symptom, however strongly marked, as constituting a difference strictly essential. We know that an extreme tendency to inflammation accompanies cholera, and it is not improbable that this may be so modified by unknown circumstances as to produce gangrene of the extremities, as well as its usual effects on the viscera.

The celebrated plague which desolated Athens and a great part of the world, about the year 430 A. C., seems to have been of a very anomalous nature. It has also been termed ignis sacer; and the accounts of it which have reached us, seem to show that the disease bore much analogy to cholera. From the poetical description of it given by Lucretius, it appears to have been attended with extreme depression of the powers of life, anxiety, spasms, burning at the stomach, intense thirst, and concluded with coma.

The Medical Board of Bombay have observed a great similarity between cholera and the species of fever which has been termed *congestive typhus* *, and accurately described by Dr. Armstrong in his celebrated work on typhus fever. It is distinguished from the other forms of typhus chiefly by the absence or partial presence of the usual symptoms of febrile excitement. "There is either a total want of morbid heat, or concentration of it from partial reactions in some parts of the body, whilst others are considerably beneath the natural temperature.

"The attacks of the most dangerous forms of the congestive typhus are generally sudden, and marked by an overpowering lassitude; deep pain, giddiness or sense of weight

* Preface to the "Reports."

in the encephalon, a dingy pallidness of the face, anxious breathing; damp, relaxed, or dry, withered skin, and those peculiar conditions of the temperature noticed above. The pulse is low, struggling, and variable, the stomach irritable; frequently there is an inability from the first to hold up the head, and the mind is more often affected with dulness, apprehension, or confusion, than with delirium. The whole appearance of the sick impresses the attentive practitioner with the idea that the system in general, and the brain in particular, are oppressed by some extraordinary load."

Dr. A. observes that the disease bears a strong analogy to apoplexy. The treatment which he recommends is in many respects the same as that which has been employed in this epidemic; bleeding, large doses of calomel, and frequently stimulants. It is very remarkable that the adoption of this novel mode of administering mercury, the employment of bleeding when counter-indicated by extreme debility, and the combination of two classes of remedies which have usually been considered as incompatible with each other — bleeding and stimulants — should thus have been put in practice in analogous diseases, without the treatment in one instance being copied from that of the other; for it does not appear that Dr. Armstrong's publication has led to the practice which has been adopted in cholera. A coincidence of this kind, and the success with which these remedies have been crowned in both instances, are alone sufficient to show that medicine is not entirely, as it has been opprobriously termed, "ars conjecturalis."

SECT. III.

OF THE RELATIONS OF CHOLERA TO THE EFFECTS OF POISONS.

A strong analogy evidently exists between the effects of the poisons and cholera. These effects differ from each other in a great degree, as they are produced by a vast number of

different substances, derived from all the three kingdoms of nature, and taken into the system in various ways; yet they appear to consist, with few exceptions, of greater or smaller collections of symptoms which are either strictly identical or perfectly analogous to those of cholera. In a great number of instances of poisoning this agreement arises to the extent of perfect identity; as is already established, for acrid poisons are enumerated by systematic writers among the causes of cholera; and we are informed that the conger eel and large white land crabs in the West Indies, on being eaten frequently produce that disease in its highest degrees *. It is not improbable that in even the generality of instances, the diseases produced by poison (if we except the narcotics) do not differ very materially from cholera.

It is difficult to fix precisely on the circumstances which constitute essential difference in disease, and such distinctions must necessarily remain in some degree uncertain and arbitrary; it is still more so to determine the various degrees of analogy which different diseases bear to each other: but these inquiries are highly important in a practical point of view; for it is evident that a knowledge of the relations of diseases to each other must enlighten our views of treatment, as it enables us to apply the experience which we have gained in one disease to others with which it is analogous, or but slightly different. If it shall be found that cholera and the affection produced by the bite of the cobra capella are the same, or nearly the same disease, the remedies which have been found so successful in the former may be expected to be beneficial in the latter.

The mineral poisons are chiefly of an acrid or caustic nature. Their effects, as described by M. Orfila, are, in general, as follows: — "Pain in the back part of the mouth, stomach, and intestines; desire to vomit, and vomiting follows with more or less violence. The bowels are occasionally constipated, at

* Thomas's Practice of Physic.

other times relaxed, and the evacuations are often bloody. To these symptoms are joined hiccup, difficulty of respiration, and almost suffocation; the pulse becomes small, hard, and concentrated; and in certain cases it may be said to vibrate under the finger like catgut. An unextinguishable thirst, difficulty of making water, cramps, the extremities of an icy coldness, horrible convulsions; general decay of strength; the features of the face changed; delirium; such are the symptoms which announce immediate death, unless energetic measures for relief are speedily put in practice. In some circumstances the intellectual faculties are preserved unchanged to the last moment*."

M. Orfila details the case of a man who had swallowed an ounce of tartar emetic, and adds: "the irritation which it excited on the alimentary canal produced a set of symptoms which I compared to *cholera morbus*." In fact the case appears from the description to have been perfect cholera, for it was marked by spasms of the muscles, and all the more prominent symptoms of the disease†.

Mr. Marshall, in the Edinburgh Medical and Surgical Journal, relates five cases of persons poisoned by arsenic. The symptoms mentioned collectively were—vomiting, pain and burning at the stomach, thirst, spasms of the legs, abdominal muscles, and intestines, purging and bilious evacuations, quick and sunk pulse, headach, vertigo, dimness of sight, intolerance of light, palpitations, chills and flushes, epilepsy, anxiety, facies hippocratica: fever preceding recovery; swelling of the face; pricking in the limbs during convalescence. Were we to make a short abstract of the principal symptoms of cholera, it must be almost verbatim the same.

The substances which produce these effects are generally taken into the stomach, and must consequently exert a local action on that organ and the intestines. To this cause the inflammation of these parts which is almost invariably found on

* Black's abridged Translation, p. 25.

† Treatise on Toxicology, vol. i.

dissection has been chiefly attributed; for we cannot doubt that arsenic or muriate of mercury, when applied to the stomach, will produce inflammation in it, in the same way that we see them inflame any other sensible part. But Mr. Brodie's experiments have shown that these occurrences are not solely to be ascribed to local action. M. Orfila relates an instance of poisoning by arsenic, applied to the head in an ointment. "The symptoms were, urgent heat over the whole body, which she described as a devouring fire; vertigoes, faintings, cardialgia, vomiting, extreme thirst, great debility." The case terminated favourably by copious bleeding. In another instance the poison was applied to a wound. "The day after the application the patient began to complain of violent colic pains, vomiting came on, and her countenance began to alter. Two days afterwards she died in violent convulsions and dreadful agonies. On opening the body we found the internal surface of the stomach and a great part of the intestinal canal in a state of inflammation, and interspersed with black spots. I am convinced this girl died poisoned by arsenic*." Further instances are adduced from Sprægel, of great inflammation of the stomach and intestines being produced by the external application of arsenic.

These circumstances seem to prove the existence of a general disposition to inflammation from poisoning, such as is known to prevail in cholera. We know too little of the nature of inflammation and the peculiarities of the alimentary canal, to be able to assign a satisfactory reason for this diathesis affecting that part of the frame so particularly; but it does not appear to be confined to those organs, for the delirium and coma with fever, which are common consequences of poisoning, are indicative of inflammation of the brain. We find also many evidences of a great and general disposition to inflammation during the recovery from these affections, and after the most acute stage of the disease has passed over, as

* Toxicology, vol. i.

in cholera. M. Orfila mentions a case of poisoning from glass of antimony, in which gangrene of the foot came on several days after the first severe symptoms had been conquered; this was also cured by amputation, and many days afterwards, when the patient was convalescent, she was attacked by a "suffocative catarrh," which proved fatal. On dissection evident marks of inflammation of the lungs were found. In detailing the common sequelæ of poisoning by muriate of mercury, the same author enumerates, "dysentery, phthisis pulmonalis, and *various inflammations*."

Mr. Duffin, in his report to the Medical Board, concerning this epidemic as it appeared at Arcot in 1787, observes: "The dreadful symptoms which I have described are similar in some measure to those which happen from verdigris mixed with food dressed in a copper vessel."

The vegetable poisons are very various, and are supposed to produce their effects by two different principles. Accordingly, they are chiefly divided into two classes, called the *acrid* or *irritating*, and *narcotic* poisons; but these qualities are frequently so much mingled in the same vegetable, and withal so different in different vegetables, that any classification of them must necessarily be very variable and arbitrary. Neither are the symptoms produced by the purest narcotic and the most highly acrid matters perfectly distinct; for opium itself, when taken in such quantities as to be called poisonous, produces not only sedative, but the highest degree of irritative effects, as spasms and convulsions, vomiting, delirium, &c.: and effects of the acrid poisons as well as of the other class, are characterized by stupor and insensibility. The whole of the vegetable poisons have not only all these but many other symptoms in common; vertigo, loss of sight, and dilated pupil, anxiety and debility. The acrid class more particularly produces violent purging and vomiting, pain and sense of heat; whence they approach more nearly to cholera; whilst the narcotics, strictly so called, are characterized by the less prevalence of these symptoms, and their peculiar effect

in producing stupor from the first; and consequently present a less degree of analogy to cholera. The effects of the vegetable poisons in general appear to differ from those of the other classes, as well as from cholera, in exhibiting less debility of the circulation, and a greater degree of increased action in that function; for we are informed that the pulse in these affections is generally strong and frequent at the first, though it rapidly sinks.

Some of the poisons of the vegetable kingdom, however, exhibit this resemblance in the most remarkable degree; that of spurious mushrooms in particular produces effects which appear perfectly identical with cholera. The following general description of their effects is given by Mr. Black in his abridgment of the celebrated work of M. Orfila. "Nausea, excessive thirst, and pain in the stomach and bowels, accompanied by purging and vomiting; these are succeeded by unquenchable thirst, convulsions, and fainting fits; the pulse becomes small, hard, and frequent; delirium ensues; and if relief be not afforded, great stupor, whence the individual is only aroused by the violence of the convulsions. These symptoms having lasted some time, cold sweats come on, and death closes the scene. In some cases the intellectual faculties are preserved entire. In general mushrooms do not manifest their action till five, seven,—or twelve hours sometimes elapse before any symptoms are felt."

The disease produced by horned or ergoted rye is particularly interestting, from the analogy which it bears to cholera, and the probability which exists that bad rice has occasionally contributed to produce the Indian epidemic. The ergot in rye is said to appear usually in hot summers succeeding to very wet springs, and is usually attributed to humidity and moisture of the soil. Its nature is undetermined, being referred by some to an insect lodging in the grain, and producing a morbid excrescence; but it has recently been attempted to be shown that it arises from a minute species of mushroom growing on the grain. It is said to be marked by a violet

skin over the grain, and its being lengthened and bent, so as to bear some resemblance to a cock's spur, from whence the term is derived. Its effects on being eaten are thus described:—"An uneasy sensation in the feet, similar to the stinging of ants (or the sensation vulgarly termed pins and needles); quickly after a sharp pain in the stomach, nausea, and great thirst; the hands and feet become affected; the fingers are so strongly contracted that the strongest man has a difficulty in pulling them straight, and the limbs appear as if out of joint. The unhappy sufferers utter the most piercing cries, and feel as if their hands and feet were consumed by fire; the head becomes heavy, as if in a state of intoxication; the eyes appear dim, and frequently blindness takes place, or the individual sees double; the body is turned back so as to form a perfect arch; the tongue is often torn by the violence of the convulsions; salivation frequently follows. Sometimes spots are observed on different parts of the body." When the poisonous matter is taken in larger quantities, it is said to produce gangrene of the extremities*. Dr. Willan informs us, that "a distressing heat and tensive pain of the stomach" characterize the disease called ergot, &c.; also "severe pain in the head, terminating in phrenzy, epilepsy, apoplexy, palsy, or lethargy, and sometimes in a total loss of hearing and sight†."

It appears that rice is frequently found to possess injurious properties; and Dr. Tytler, of the Bengal Establishment, considers this as the sole cause of the epidemic cholera. He informs us, that in many cases of death from that disease the symptoms have so strongly resembled poisoning as to give rise to suspicions of that crime having been committed, and even to bring the subjects to judicial investigation. He also mentions that he has fed animals on the kind of rice which he supposes to have produced the disease (the "Ouse rice"), and that they have died with some symptoms resembling cho-

* Black's translation of Orfila, p. 99.

† Treatise on Cutaneous Diseases, p. 500.

lera. It is extremely probable that poisonous rice will produce cholera; but identity of effect alone is insufficient to prove identity of cause. It is unquestionable that cholera, as well as other diseases, has many causes. We have no reason to suspect any injurious quality of the rice in this part of India; and I can venture to say that the opinion is not at all entertained either by the natives or Europeans on this establishment. Admitting even that the cause alleged was universally present, it would be quite insufficient to account for the gradual spreading of the disease, and its sudden appearance; and would be perfectly inconsistent with its sudden, and frequently total disappearance. It is probable, however, that this agent has had even a great influence as an exciting cause, when present in any degree; for we know that when a predisposition to disease exists, many causes are sufficient to excite it into action, which at other times are perfectly harmless.

Dr. Horsefield, in the Transactions of the Batavian Literary Society*, gives the following account of the effects of the poison of the upas tree of Java, inserted into a wound.

"The common train of symptoms is, a trembling and shivering of the extremities, restlessness, discharges from the bowels, drooping and faintness, slight spasms and convulsions, hasty breathing, an increased flow of saliva, spasmodic contractions of the pectoral and abdominal muscles, retching, vomiting, great agony, laborious breathing, violent and repeated convulsions, death."

The *tshettik*, a poison prepared from another Javan vegetable, is said to be of a more violent nature, and to affect more particularly the brain and nervous system; producing faintness, convulsions, and an affection resembling apoplexy. The effects produced by introducing these poisons into the stomach did not differ materially from those which followed their insertion into a wound.

* Journal of Science and the Arts, No. 4.

The appearances on dissection were likewise similar to those which we meet with in cholera: excessive congestion of the blood in the viscera, particularly the lungs; and, from the tshettik, very marked inflammation of the brain. "The brain and dura mater showed marks of a most violent and excessive affection. In some instances the inflammation of the dura mater was so strong, that, on the first inspection, Dr. H. supposed it to be the consequence of a blow previously received*."

The effects of the animal poisons in general present still stronger analogies to cholera than the other classes; and it is highly probable that such of them as are taken into the stomach, always give rise to that disease itself in some of its various degrees and forms; for in the enumerations of their symptoms which are given by authors, we perceive nearly all the principal symptoms of cholera: "Headach, nausea, vomiting, purging, pain in the bowels, convulsions, twitchings and pain in the limbs, burning in the throat, inflammation of the stomach, horrible convulsions, extreme debility and fainting, constriction of the chest, pricking, itching, and eruptions of the skin†." The following additional symptoms are given in Thomas's Practice of Physic: "Great restlessness, and flushings of the face, giddiness, cardialgia; pulse at first quick and hard; tenesmus; dysuria; salivation, and sometimes yellowness of the eyes and skin. When the poison is violent, excessive convulsions, feeble pulse, great debility, and death."

Oysters in India very commonly produce slight, and sometimes violent attacks of cholera, in persons arriving at the sea coast, and consequently unaccustomed to eating them. In the beginning of 1819, I witnessed the curious circumstance of a sort of epidemic disease produced by a single basket-full of these animals. A cooly load of them was pro-

* This observation may be compared with that of Mr. Annesley, at p. 43.

† Black's Translation of Orfila, p. 119.

cured from the sea-coast to a large camp at some distance from it, and distributed among the officers; the consequence was an almost universal complaint of vomiting and purging amongst them, which in some instances was alarming, but without any serious consequences. The quantity that was eaten by each was, in general, extremely small, and scarcely sufficient to account for these attacks; and as the cholera had prevailed in the camp shortly before, and returned a few months afterwards, it is probable that some predisposition to the disease was present, to which they were owing as much as to the oysters.

The poison of snakes, and other venomous animals, introduced into the system by a wound, produces effects very similar to cholera, although some of the more prominent symptoms of the disease, particularly the purging, are not usually mentioned in the accounts which are given of them. But two cases are related at p. 107 of the eighth volume of the Philosophical Transactions, which were characterized by vomiting, *purging*, and excessive debility, arising from bites of the viper. Dr. Mead gives the following detail of the symptoms which follow the bite of that reptile: "Acute pain in the bitten part, great faintness, a quick, low, and sometimes interrupted pulse, great sickness at stomach with bilious convulsive vomitings, cold sweats, and pains about the navel. Some serpents kill by a fatal sleep, others are said to produce an universal hæmorrhage and dissolution of the blood, and others an unquenchable thirst." M. Orfila also expressly mentions convulsions in similar cases. The effects of the bite of the cobra di capello (or as it is commonly called, cobra capell, the hooded snake) do not appear to differ except in degree from the above account of the effects of the bite of the viper. They are chiefly marked by extreme debility of the circulation and animal functions, cold sweats, vomiting, spasms or convulsions, anxiety and stupor.

Mr. Coats, in a report to the Medical Board of Bombay, observes: "I should have pronounced that some of my pa-

tients (with cholera) had been labouring under snake-bites, had I not been better informed*." A medical officer of this Establishment makes a similar remark in a report to the Board. This resemblance was also pointed out by myself in an official report, about a year ago, entirely unconnected with theory.

Mr. Connell, staff-surgeon of this establishment, in one of his reports observes: "Whatever may be the nature of the exciting cause, it seems most apt to affect those of delicate constitutions, or who have been debilitated by previous illness; and its effects are such as if a highly sedative poison was taken into the system, as neither the vomiting, nor purging, nor spasms, will account for such a sudden failure of the powers of life, as happen in this disease."

The Medical Board of Bombay have entertained a similar idea of the nature of the disease. "Concealed from our view as the proximate cause of this formidable malady may ever remain, we have only to observe its effects, and the united testimony of all who have witnessed it seems to show, that it is *somewhat* which presses heavily upon the vital functions, and on many occasions resembles the effects of a poison taken into the stomach or applied to the blood; but whether it acts more immediately upon the circulating system or the nervous, we cannot determine; the various modes of attack, which have given rise to the divisions of the disease into species and varieties, would lead to the supposition that sometimes the one, and sometimes the other may be the case†."

In the Edinburgh Medical Journal, a case of disease from the sting of a bee (occurring twice in the same person) is mentioned, which bears a marked similarity to cholera. "It begun like severe water-brash; this was quickly followed by vomiting, purging, great distress, syncope, low pulse, sweat-

* Reports on the Epidemic, p. 153.

† Preface to the "Reports."

ing, and blindness, and lasted seven hours." A similar most severe attack from the same cause, in a person of irritable habit, has come to my personal knowledge.

The sting of the scorpion, though extremely painful, is rarely attended with danger; but in one instance I have seen it fatal. A sepoy under my charge, several years ago, was stung in the foot, and shortly afterwards attacked with vomiting, purging, coldness, extreme debility, and all the principal symptoms of the present epidemic. He died in less than twenty-four hours from the accident; and the case was reported under the head of cholera.

The Abbé Fontana has shown, that the blood of animals killed by the bites of snakes is invariably of very dark colour; and M. Orfila repeatedly mentions similar appearances in his dissections of persons and animals who had died from various poisons. This, then, exhibits another remarkable point of analogy between these affections and cholera.

It has long been a subject of controversy, and appears to be still undetermined, whether the poisons in general exert their influence immediately on the nerves, or whether it is necessary that they should be absorbed into the circulation before they can produce their effects. Much evidence has been adduced on these interesting questions, which tends to prove that some of these agents affect the frame in the former of these ways, and others in the latter. Mr. Brodie infers from his experiments, that "alcohol, the essential oil of bitter almonds, the juice of aconite, the empyreumatic oil of tobacco, and the woorara, act as poisons by simply destroying the functions of the brain.

"There is reason to believe that the poisons, which in these experiments were applied internally, produce their effects through the medium of the nerves, without being absorbed into the circulation.

"When the woorara is applied to a wound, it produces its effects on the brain by entering the circulation through the

divided blood-vessels; and from analogy we may conclude that other poisons when applied to wounds operate in a similar manner.

"Arsenic, the muriate of barytes, and emetic tartar, do not produce their immediate effects until they have passed into the circulation*."

The most received opinion regarding the rationale of the effects of poisons, refers them to disorder of the nervous system; for their phenomena are strongly in support of this position; and the great similarity of these phenomena, though produced by very different substances, and taken into the system in various ways, argues a similarity of their proximate causes. In many instances it has been clearly inferred, that this derangement of the nervous system consists in the diminution or suppression of its energies; and though it should be proved that poisons usually exert their influence through the medium of the circulation, it would not be adverse to that opinion; for it is evident that they may destroy the nervous energy, not only by their immediate action on the extremities of the nerves, but by destroying the healthy condition of the blood; as it has been proved in the clearest manner, that such condition is necessary to enable the nervous system to perform its functions. Numerous experiments have shown, that the injection of venous blood, or almost any foreign matter, into the arteries which supply the brain, destroys the action of that organ. Accordingly Mr. Brodie has inferred, that the woorara, when applied to a wound, in this way produces its effects on the brain.

If, then, it shall be proved that the effects usually arising from poisons are owing to diminution and consequent privation of nervous energy (and there are very few general positions in pathology more firmly supported by tangible facts), the resemblance between these effects and cholera will be

* Edinburgh Medical and Surgical Journal for October, 1812.

strongly in support of the pathology of that disease which has been attempted to be established.

The disorder of the system which in a greater or less degree always follows a debauch, bears so strong a resemblance to the commencement of cholera, that the first symptoms of the epidemic have frequently been disregarded, under the idea that they arose solely from that cause. It is characterised by giddiness, headach, tremor, debility, anxiety and depression of spirits; accelerated pulse, thirst, perspiration, vomiting, and excessive secretion of bile. To the last mentioned symptom much of the bad effects of drinking have been attributed; but it is much more probable, that in this instance, as well as in cholera, it is an effect, and not the cause of the disordered state of the whole system which accompanies it.

In the higher degrees of these affections, which succeed to fits of hard drinking of many days or even weeks continuance, we observe the same extreme anxiety, causeless terror and despondency, which are characteristic of cholera. Amongst soldiers in India, this state has received the expressive name of *the horrors;* and it frequently becomes so intolerable as to lead to suicide, and to induce them to adopt the horrible and almost incredible expedient of getting rid of existence through the hands of the law, by committing murder.

I have lately met with a case of anomalous disease, arising immediately from excessive drinking, and bearing considerable resemblance to *delirium tremens,* which exhibited the same uncontrollable disposition to inflammation which is so frequently evinced in the protracted cases of cholera. It was accompanied by an extremely quick and weak pulse, and in the earlier stages by all the marks of high inflammation of the stomach; on that affection subsiding, inflammation of the brain came on, and occasioned death, as was proved on dissection.

Many of these phenomena are clearly indicative of dimi-

nution of nervous energy, and it may be presumed that they all arise from that cause. Mr. Brodie has inferred from experiment, that alcohol destroys the energy of the brain.

SECT. IV.

OF THE RELATIONS OF CHOLERA TO SOME OTHER DISEASES OF THE CLASS NEUROSES.

Tetanus and hydrophobia have always been considered as analogous diseases. They resemble each other in the local origin which both of them usually have; in their highly dangerous nature; in their being in a great measure confined to the animal functions; and in the spasmodic affections by which they are chiefly characterized. Each of these diseases also exhibits many strong points of analogy to cholera. In cholera we observe all that extreme anxiety, despondency, terror, and excessive suffering, apparently little connected with bodily *pain*, which are so remarkable in hydrophobia. The occasional increase and subsequent abolition of sensibility, as occurring in the former disease, have already been noticed in comparison with the latter. Vomiting is a common attendant on both; notwithstanding the dread of water (which arises solely from the dread of the paroxysms produced by the attempt to *swallow* liquids), thirst is a very constant symptom of hydrophobia; and it is probable that the same general tendency to inflammation exists in that disease as in cholera; for many marks of that affection are constantly found on dissection of persons who have died of rabies.

In Dr. Marshall's treatise on the brain, two cases of hydrophobia are detailed, apparently with much accuracy; and the appearances on dissection are very similar to those of cholera: turgescence of the large vessels, and injection of the small vessels of the brain with blood; appearances of inflam-

mation in the internal coats of the stomach and intestines, in the fauces, heart, lungs, and pleura. In both cases little urine had been made, and the bladders were found empty. In another case it is likewise mentioned, that the bladder was found contracted to a very small size, and did not contain a drop of urine. The large arteries were found much smaller than natural; and it is inferred that by their contraction the blood had been forced into the smaller vessels.

The analogy between tetanus and cholera has been long and generally observed. An eminent teacher of medicine (Dr. Curry), terms the latter disease, as it appears in India, "a tetanic form of cholera." Bontius, an old Dutch writer, who witnessed this disease at Batavia, describes it under the name of *the spasm*, and does not distinguish it from tetanus. Dr. Girdlestone considered it as identical with idiopathic tetanus*. Mr. Craw, in an interesting letter pub-

* As Dr. G.'s little work is rarely to be met with, the brief description which he gives of the disease may be acceptable here.

"Spasms were the first diseases which appeared among the troops who arrived at Madras in October, 1782, under the command of Major General Sir John Burgoyne. More than fifty of these fresh men were killed by them within the first three days after they were landed in the country; and in less than a month from that time, upwards of a thousand had suffered from attacks of these complaints.

"The tetanus or spasm is distinguished by medical writers into various species, according either to the particular parts affected with contraction, or the duration of the disease. I shall, without specifying their distinctions, describe the various phenomena as generally observed in India. I must, however, previously observe, that, though I have seen many wounds in India, I never saw a wounded person affected with spasms, except in the agonies of death; therefore I can by no means affirm that the following observations are equally applicable to those tetanic affections which are described by authors as arising from wounds, because such cases, from their peculiar exciting causes, must be still more untractable and hazardous.

"The symptoms which commonly first presented themselves were, coldness of the surface of the body, especially of the hands, feebleness of the pulse, and spasmodic contractions of the lower extremities, soon

blished by the Bombay Medical Board, takes a similar view of its nature. "The disease affecting many of the Europeans, appears to me to be a true *tetanus;* and though my professional friends (as it appears to me misled by the irritability of the stomach and bowels) will not at all accord with me in my views, I regard our present epidemic in all its classes as much more nearly allied to tetanus than to cholera. The last is surely a misnomer, as applied to a disease, the principal characteristic of which is an entire want of ΧΟΛΗ

extending to the muscles of the abdomen, diaphragm, and ribs. As the spasms advanced, the muscles might be seen to assume the rigidity of cartilages; sometimes causing the body to remain immoveably extended, sometimes bending the trunk through its whole length anteriorly, and sometimes, though seldomer, backwards. The parts in which the spasms began generally remained rigid, but those which were subsequently seized with them had momentary intermissions of the contractions; the only intervals of relief experienced by the patient from the most tormenting pains. The hands and feet then generally became sodden with cold sweats; the nails livid, the pulse more feeble and frequent, and the breath so condensed as to be seen and felt issuing in a cold stream at a considerable distance. The thirst was insatiable, the tongue whitish, but never dry; vomiting became almost incessant; the spasms, cold sweats, and thirst, increased with the vomitings, which last, if not checked, soon terminated the existence of the patient.

"In this manner, most commonly, was the succession of the phenomena: but often they were so rapid in their attack that they seemed to seize the patient all in conjunction instantaneously. The cold sweats and spasms were constantly found to increase with the retchings.

"In some few the extremities remained warm; in others also the spasms were only clonic or convulsive. Some died in the first hour of the attack; others lived a day or two with remissions, when they died either of universal spasms or an apoplexy."

Drunkenness, damps from the earth, and exposure to cold, are the principal causes to which he attributes the disease.

The warm bath and wrapping up in blankets, with the use of opium, and particularly the liberal use of hot madeira wine, were chiefly depended on in the treatment. The cold bath was tried, but found to be extremely injurious. Draughts of any liquid were found to make the vomitings recur, consequently they were given in very small quantities.

in the evacuations. In the 56th regiment and the horse and foot artillery the disease sometimes makes its appearance, with the same affection of the stomach and bowels as in the natives, frequently with spasm in the feet, legs, abdominal muscles, or arms; but in all the spasmodic affection is the pre-eminent one; headach, pain in the eyes, excruciating pain at the scrobiculus cordis (a pathognomonic symptom of tetanus), quick, full, hard pulse, but labouring and oppressed, according to the violence of the spasms; retention or difficulty of voiding the urine; strong and violent spasms, drawing up the legs, rigidly contracting the arms and fingers, bending the body forwards or backwards, or laterally, the patient at the same time exerting such physical strength as requires half a dozen of men to hold him on his cot*."

It must however be observed, that there are some very essential differences between cholera and tetanus. In tetanus the animal functions are almost exclusively affected until near the fatal termination: in cholera the organic functions appear to suffer, in general, even more than the animal functions. Tetanus is a highly dangerous affection: but those cases of cholera, which, from the violence of the muscular spasms, and less affection of the other parts of the system, most nearly resemble tetanus, are usually among the most tractable, and are infinitely less dangerous than that disease. Tetanus usually continues many days, or even weeks, before it terminates in death or recovery, whilst the spasmodic affections of cholera rarely continue twenty-four hours.

Does not inflammation constantly occur in the last stages of tetanus as well as in cholera? In one case of that disease which I have witnessed (arising from a slight puncture, and exposure to cold, from a very great and sudden change of temperature, experienced on ascending the eastern edge of the table land of Mysore), the fatal termination was preceded by evident marks of inflammation of the brain. In the

* Reports, p. 42.

seventh volume of the Medico-Chirurgical Transactions, Dr. M'Arthur details the appearances on dissection of four cases of tetanus. In all evident and great appearances of inflammation in the stomach and intestines are mentioned, which in two of them had run on to perfect gangrene. He adds, "the inflammation in this disease is different from enteritis, and from that which is present in persons who have died of the endemial fever of this country (the West Indies). In enteritis the intestines often adhere to each other by layers of coagulable lymph recently thrown out, flakes of curdled matter are often found, and pus is sometimes formed; in the inflammation attending tetanus there are no adhesions, no formation of pus." In cholera, likewise, the inflammation of the intestines appears to be unattended with the secretion of pus; and it has already been observed that adhesions of them are not found; but since that remark was made I have met with one instance, in which it is recorded that their folds were found adhering to each other.

Apoplexy is usually considered to arise from pressure on the brain, in consequence of accumulation of blood in the vessels of that organ, or extravasation of blood or serum. But it is ascertained that these causes are not universally present in the disease; for in that species which has been termed *serous apoplexy*, the very opposite state of the system to plethora usually prevails, and on dissection the brain frequently exhibits no evident marks of disease. These occurrences are explained on the supposition which Cullen has made, of causes acting immediately upon the nervous system, and destroying its mobility or energy.

"Besides the causes now mentioned occasioning apoplexy by compression, I allege there are other causes producing the same disease, by directly destroying the mobility of the nervous power. Such causes seem to be, the mephitic vapour arising from fermenting liquors, and from many other sources; the fumes arising from burning charcoal; the fumes of mercury, of lead, and of some other metallic substances; opium,

alcohol, and many other narcotic poisons: to all which I would add the power of cold, of concussion, of electricity, and of certain passions of the mind. I believe the immediate and direct action of these poisons or noxious powers to be upon the nervous power, destroying its mobility, because the same poisons show their power in destroying the irritability of muscles and of the nerves connected with them, when both these are entirely separated from the body*."

We have much evidence of the immediate destruction of the nervous power in cholera; and we have demonstration of the presence of the common cause of apoplexy—compression of the brain from the fulness of its vessels—existing in cholera: we know that compression of the brain destroys its energies, and we have therefore two causes operating at once to produce the same effect. And as we are unable to measure the respective quantities of these causes, it is difficult or impossible to determine how much of the apoplectic state which attends cholera is owing to pressure on the brain, and how much to the original cause of the disease.

The first part of this proposition may, however, be denied, and congestion in the brain may be considered as the sole cause of the loss of its energy, evinced by insensibility, fixed and dilated pupil, and other symptoms of apoplexy. On this hypothesis we should expect to find these affections most prevalent in plethoric habits; but as far as my observation extends, they are most remarkable in the weakly and exsanguineous. If congestion was the principal morbid affection of cholera, we should surely find it, like sanguineous apoplexy, attacking chiefly fat and plethoric persons; but, on the contrary, it is well known that it affects particularly those of the very opposite habits; those whose frames are naturally weakly or sickly, or debilitated and emptied by previous illness, or insufficiency of nourishing food.

On the other hand, it is much more probable that the ori-

* First Lines, vol. iii, p. 168.

ginal diminution of the nervous energy is the *cause* of the congestion which appears in the brain; thus giving rise to pressure, which further diminishes that energy. The luminous views of Cullen regarding the causes of some species of apoplexy, are strongly in support of this opinion.

"With respect, however, to the circumstances which may appear upon the dissections of persons dead of apoplexy, there may be some fallacy in judging from these circumstances of the cause of the disease. *Whatever takes off or diminishes the mobility of the nervous power may very much retard the motion of the blood in the vessels of the brain;* and that perhaps to the degree of increasing exhalation, or even of occasioning rupture or effusion; so that in such cases the marks of compression may appear upon dissection, though the disease had truly depended on causes destroying the mobility of the nervous power. This seems to be illustrated and confirmed from what occurs in many cases of epilepsy. In some of these, after a repetition of the fits, recovered from in the usual manner, a fatuity is induced, which commonly depends upon a watery inundation of the brain; and in other cases of epilepsy, when fits have been often repeated without any permanent consequence, there happens at length a fatal paroxysm; and upon dissection it appears that an effusion of blood had happened. This, I think, is to be considered as a cause of death, not a cause of the disease: for in such cases, I suppose that the disease had diminished the action of the vessels of the brain, and thereby given occasion to a stagnation, which produced the appearances mentioned. And I apprehend the same reasoning will apply to the cases of retrocedent gout, which by destroying the energy of the brain may occasion such a stagnation as will produce rupture, effusion, and death; and in such a case the appearances upon dissection might lead us to think that the apoplexy had depended entirely upon compression*."

The general venous congestion of cholera is capable of

* First Lines, para. 172.

being explained on the most simple and obvious principles:—it is well known that the arteries are found nearly empty after death in all diseases, the blood which the frame contains being found almost wholly in the venous system; circumstances which are clearly referrible to the greater vitality or contractile power which arteries are known to possess over veins; by which they continue to act and to empty themselves into the veins after the vital power of the latter has ceased. In disease the quantity of blood in the whole system appears to become gradually and greatly diminished, by the interruption to digestion, and by the efforts of nature and of art; consequently, in ordinary cases of natural death, the veins, though they contain nearly the whole of that fluid, do not present that turgid appearance which they exhibit in cholera. But from the short duration of this disease, time is not allowed for this diminution of the quantity of blood to take place; the circulating system becomes extremely enfeebled, and the arteries acting somewhat longer and more strongly than the veins, the whole of the blood which is natural to the state of health becomes collected in the veins. Accordingly it is found, that in almost all cases of sudden death, from whatever disease, the internal veins are extremely turgid. The large quantity of blood which the system contained on the attack is not removed—it must be still in the vessels—and from the causes just assigned it can be only in the veins.

It is, then, pretty evident that the congestion of blood in cholera is owing to simple debility of the circulation; and, consequently, though it keeps up and increases the state which produced it, it cannot be the original cause of this debility; for it is necessary that cause should precede effect.

The principal points of analogy between apoplexy and cholera have already been pointed out. Another may be added; that the former of these diseases, as well as the latter, has been observed to prevail so extensively at particular periods as to assume in some degree the form of an epidemic*.

* Morgagni "de Causis et Sedibus Morborum."

Two instances have come to my notice, of persons predisposed to epilepsy suffering from that disease in combination with cholera. One of them was an officer, who was a martyr to epilepsy from intemperance. On this occasion the accession of cholera appeared to be the exciting cause of that of epilepsy. He was carried off in a few hours by their combined attacks. In the other there was retching and violent spasms of the intestines and abdominal muscles, together with perfect epileptic convulsions, but without the sopor which usually follows them. The case terminated favourably from bleeding.

In colic and diarrhœa we meet with the greater number of affections of the chylopoietic organs which occur in cholera, and some others in other parts of the system, which bear the same analogy. The Devonshire or Poictou colic is attended by pain and anguish at the pit of the stomach; spasms of the intestines and abdominal muscles; excessive vomiting, chiefly of bile; suppression of urine and strangury; a small and unequal pulse; cold sweat; fever; and, after two or three days, spontaneous purging*. The muscles of the extremities are also affected in that disease, but it appears to be with paralysis only; whilst in cholera they are chiefly affected with spasm.

This epidemic has frequently been observed to begin with a common diarrhœa, which has gradually assumed the form of cholera, so as to occasion a great difficulty in the diagnosis in the early stages. Similar circumstances have been observed in the cholera of Europe. Mr. Robertson, in a Report on the diseases of Edinburgh for August 1808†, remarks: — "Diarrhœa still continues with considerable violence; indeed, with the addition of cholera, it constitutes the principal disease for August. Last month diarrhœa continued to increase in severity; and about the end of it, this disease in some instances gradually and almost imperceptibly assumed

* Huxham, "de Morbo Colico Damnoniorum."

† Med. and Phys. Journal.

the symptoms of cholera. Thus, probably from a peculiarity of constitution of the individuals, some were seized with the one, and some with the other of these complaints; whilst others were first seized with diarrhœa and afterwards with cholera."

Diarrhœa is also attended by depression of spirits and other uncomfortable sensations, paleness and debility; which frequently, like the corresponding affections of cholera, bear no proportion to the quantity of the evacuations. It is probable, likewise, that the secretion of bile becomes greatly diminished or suppressed in the higher degrees of diarrhœa and hypercatharsis; as the stools in these cases usually assume much of the white or colourless and watery appearances of those of this epidemic.

The disease in the horse called *the gripes* (which is very common in India), seems to bear a perfect analogy to cholera. It is equally sudden in its attack, rapid and dangerous in its course, short in its duration; and, when recovery takes place, it is equally quick as in this epidemic. The animal is incapable of vomiting, consequently that symptom cannot be present, but the disease is attended with watery purging, indications of pain and spasm in the bowels and abdominal muscles, excessive sweating, extreme anxiety and restlessness, great and sudden debility, coldness of the ears, and, as it is said, with suppression of urine. Inflammation of the bowels is also found on dissection. It may be added, that similar treatment to that of cholera has been found successful in this affection. Large bleedings are the established remedy in India. In a very desperate case which occurred lately in a horse of my own, this analogy led me to employ another of the usual remedies of cholera, one hundred grains of calomel were given after a copious bleeding; and in a few hours the animal appeared perfectly well and hungry. Further, it has been observed in Bengal, that the gripes was uncommonly prevalent among horses at the same time with the epidemic.

From the preceding observations it will be evident, that this singular disease bears very strong analogies to many others of the neuroses. And from its resemblance to congestive typhus, to the cold stage, and occasionally to the hot stage of fever, and the constant occurrence of inflammation in various parts of the frame, it is equally evident that it possesses scarcely less affinity to the pyrexiæ. Many of the diseases which have been compared to it appear to differ from it chiefly in their being confined to certain parts of the system: and, in fact, if we suppose a combination of various degrees of tetanus, syncope, apoplexy, colic, and diarrhœa, with phrenitis, or gastritis, and enteritis, we shall have a disease bearing a very strong resemblance to cholera.

CHAP. VI.

OF THE REMOTE CAUSES OF EPIDEMICS IN GENERAL.

LIFE is the *sine qua non* of all temporal good, and animal instinct as well as reason impel us to its preservation when endangered, with a force to which, under common circumstances, all other motives are unequal. Health is a benefit of scarcely less importance, for without it life itself is of no value. The causes which tend to deprive us of these blessings must therefore be objects of the highest interest to man, even as a selfish individual, and infinitely more so to him as linked to society by the ties of domestic affection and philanthropy. Of all these causes there are few which can be compared to those of epidemical diseases; for they have not only destroyed the greatest number of those who have been prematurely swept off, but they have usually put an end to life in the most rapid and violent manner. The world appears to have been comparatively free from these disorders in their highest degrees for a great number of years; but history affords the most awful instances of their ravages, and the last three years have brought similar events before our eyes in India. Nothing in nature surely can be so appalling as those visitations of the plague which have occurred from time to time, depopulating the largest cities, and spreading in short periods of time over great portions of the known world; or the still more fatal, though less durable, attacks of the sweating sickness and cholera; the former of which is said to have extended over one-half of England in a day, carrying off one-third of the whole population, and destroying those whom

it seized in a few hours; and the latter is known to have swept off, in a single camp alone, six or eight thousand persons in the course of twelve days! We well know that these events must have some physical causes, proportionate in magnitude to their effects; and a clear elucidation of them, although it did not place them within our power, would be one of the highest gratifications that human curiosity could receive. It is not, however, to the indulgence of this passion that the results of such discoveries would be confined: in all probability they would lead to some decisive means of prevention and cure; for, *viæ ad scientiam atque potentiam humanam conjunctissimæ, et fere eadem sunt;* "knowledge is power," and its benefits are perfectly incalculable.

Accordingly we find inquiries into the causes of epidemics forming a prominent feature of the medical writings of every age. I cannot pretend to give an abstract of these researches, but the inference which appears to have been almost unanimously drawn from them, and which is at once the most obvious and apparently the only feasible way of accounting for these visitations, is, that they depend primarily on some disordered state or states of the atmosphere. Many other causes have indeed been adduced, that doubtless contribute to produce them, the principal of which is contagion: but it has been clearly shown, that that agent alone, in a vast number of instances, is totally insufficient to account for their prevalence; for, on one hand, it is found that they frequently appear when there is no sufficient evidence of the presence of contagion, and spread so suddenly and extensively as to preclude all explanations of that kind, though the importation of infected persons or the morbific fomites is proved; and, on the other hand, they are found not to spread generally and to cease though these causes are actually present.

"The operation of some general agent, inducing a predisposition to become affected by contagion, or other exciting causes of disease, would appear to be the principal source of the predominance of epidemics. The contagion of small-pox

and scarlet fever perpetually exists among us, yet it is only at particular times that these diseases attack so many individuals as to be called epidemic. The principal plague years of the seventeenth century were 1603, 1625, 1636, and 1665; in which the number of deaths from the plague in London were 36,000, 35,000, 10,000, and 68,000 respectively; but so far was the disease from being extinct in the intermediate periods, that from the year 1603 to 1667, the bills of mortality exhibit only three years entirely free from the plague. It is obvious therefore, that the presence of infectious matter, or other exciting cause, is not alone sufficient to produce an epidemic disease*."

Chemistry does not, however, appear to have thrown any light on this dark subject, by detecting any specific variation from the natural state of the atmosphere during the prevalence of these diseases; and we are ignorant whether it is one peculiar condition of that fluid, which, singly or combining with particular causes (as specific contagion), produces all epidemics, or whether each of them arises, as Sydenham supposes, from a different "hidden constitution of the air." A late ingenious writer (Mr. Noah Webster of America) supports the former of these opinions, and endeavours to show, that epidemic diseases are owing to a certain principle, which is contained not only in the atmosphere, but throughout the whole physical world, and produces not only these, but nearly all the other great disturbances of nature.

"Mr. Webster has filled two volumes with evidence, which he believes goes far to prove the existence and operation of some general agent, or *pestilential principle*, throughout the physical world. To this agent he ascribes the origin of earthquakes, and volcanos, and meteors; and he seems to consider it as the medium by which comets affect the earth, producing tempestuous seasons, great heats and colds. He has collected with great industry an historical account of the

* Rees's Cyclopædia, article *Epidemic*.

various epidemic and pestilential visitations on record, which have successively occurred to different countries, and has connected with it a chronological view of the appearance of comets, the eruptions of volcanoes, the commotions of the earth, and the various atmospherical phenomena which have been described by authors, in order to prove this coincidence. 'All the comets,' says Mr. Webster, 'which have approached the earth in their passage to and from the sun, especially those which have passed very near us, have been preceded and attended by most extraordinary effects; as great heat and drought in summer, and severe cold in winter, deluging rains, violent tempests, and unusual tides. They occur so uniformly with the appearance of these bodies, and for some months preceding and following, as to leave no room to question the influence from which they proceed.' Aristotle, Pliny, and Seneca are quoted to prove that great heat, tides, and winds are the usual concomitants of comets. A great number of records are quoted by Mr. Webster to prove the connection between earthquakes and epidemics, an opinion which many writers have adopted. It appears, however, that great pestilence, even when occurring within a short period of earthquakes, has generally appeared before the earthquakes; thus, after the plague in London in 1665, shocks are said to have been felt on the continent. Mr. Webster believes that pestilence and earthquakes depend upon one common cause, which excites into action the internal fires: but he supposes the action or fermentation may precede for months, or even years, the explosion in earthquakes; and by means of insensible vapour, or heat, or electric discharges, the elements of water and air may be affected in such a manner, as to impair the principle of animal and vegetable life.

"'In all the great plagues which have affected the human race, other animals, as horses, cats, dogs, and fowls, together with fish in rivers and the ocean, and even vegetables, have borne their share in the calamity; the pestilential principle has extended to every principle of life. The beasts of the field

perish with deadly epidemics; the fish on the bottom of rivers and the sea die, or become lean and sickly; while corn is blasted on the most fertile plains, and the fruits in gardens and orchards wither, or fail to arrive at their usual perfection*.' "

These observations are sufficient to show that the causes of epidemics are usually very generally and widely diffused; and they are strongly in support of the received opinion, that the deleterious agent, as far as it affects life, exists in the atmosphere.

I will now take advantage of a very valuable article, that has recently appeared in the Edinburgh Review, on the epidemic fever which has prevailed to a very great extent in the British Isles, *during the very time that India has been afflicted with cholera.* It contains a large portion of the information which we possess regarding the causes of epidemical diseases, in a condensed and popular form, and in the usual masterly style of that work. The author begins by noticing, as common causes of these diseases, specific contagion — want of the necessaries of life — filth — intemperance — and depression or anxiety of mind; and shows that many of these circumstances have preceded and accompanied the epidemic alluded to. The recent peace, the stagnation of trade, and the failure of crops, had deprived great numbers of their usual means of subsistence; producing privation of food, fire, and clothing, and necessarily attended by idleness, intemperance, and filth, combined with despondency and despair. He thus continues: —

" Although the predisposing circumstances already pointed out must be highly instrumental in exciting and diffusing typhus, still it is evident something more must happen ere that fever can prevail as an epidemic. To be convinced of this, we have only to recollect, that at all times, in a crowded society like ours, contagion must meet with mental depression

* Rees's Cyclopædia, article *Epidemic.*

from moral causes, and exhaustion from scarcity, with all their sequelæ of filth, intemperance, and the like, ready prepared to aid its operation. But seeing that even under this conjunction of circumstances, epidemics do not prevail at all times, nor even very frequently, it is manifest some additional auxiliary must yet be wanting. The contagion of measles, scarlet fever, or whooping-cough, like that of typhus, is never wholly extinct in any country; yet these diseases only prevail epidemically during particular seasons: it therefore becomes a very interesting point in medical physics, to determine the reason why they spread some years so much more widely than others. We cannot say that we have yet met with any very satisfactory solution of this curious and interesting question. The phenomenon, we are afraid, cannot be explained: and we must be content, in our ignorance, to refer it to the influence of what was styled by Sydenham and the older physicians, 'peculiar constitutions of the air' during certain years, or portions of years, disposing the body to take on one kind of disease in preference to another. What this peculiar state or constitution of the atmosphere favourable to epidemics is, we know not: yet we cannot help believing that it exists; and that the occult quality, whatever it may be, has no relation to the thermometrical or barometrical conditions of that fluid. Whether it is at all connected with its electrical states, it would be fruitless to conjecture. Sydenham conceives, upon slight enough grounds, that 'it proceeds from a secret and inexplicable alteration in the bowels of the earth, whereby the air is contaminated with such effluvia as dispose bodies to this or that disease, as long as the same constitution prevails; which at length, in a certain space of time, withdraws and gives way to another.' For our parts, from attending to the history of health and diseases during the succession of seasons, we are persuaded that changes of mighty importance take place in the air we breathe, without their being at all appreciable by either our eudiometers or

hygrometers; and this we must at present be satisfied to receive as an ultimate fact, for which we cannot account.

"The existence of a special condition in the air, as the leading cause of the spreading of various epidemics, is by no means without close analogy in its favour. For example every one knows that in the East Indies, liver complaints are remarkably frequent; though the climate, so far as depends on heat, moisture, &c., is entirely like that of the West Indies, where such complaints are comparatively rare. Again: it is a matter of almost daily observation, that an east wind is highly disagreeable to valetudinarians, and unfavourable to the cure of some diseases: it has even been known, in the course of one night, to change for the worse all the ulcers in a large hospital. This, however, must be attributed to some latent peculiarity in the wind that now and then blows from that quarter; for neither its cold, its dryness, nor its barometrical properties, can account for the effects it occasionally produces.

"This unknown constitution of the atmosphere, then, we take to be a *sine qua non* in the production of epidemic fever; and that, if contagion is a prerequisite to render the spreading of the disease possible, the aerial change is also a prerequisite to render that spreading probable. When these two principal causes meet with the favouring circumstances formerly explained, all of them act and react interchangeably upon each other; and the result of such a complication and union of noxious agencies, is an epidemic such as we see it."

Such are the causes to which epidemical diseases are usually attributed. It is evidently desirable to ascertain how many of them have not existed in India previous to, or during the prevalence of the present epidemic; in order that the question of its origin may be reduced to its greatest possible simplicity.

The calamities attendant on war have appeared to be a great cause of these diseases. India was in a state of war-

fare about the commencement of the epidemic, but it was not productive of great or general calamity; large portions of the country were entirely out of its influence, and in these the disease has prevailed with not less violence than in other parts. No scarcity of food preceded the epidemic, or existed during the years 1817 and 1818, when it committed its greatest ravages; nor is there the smallest evidence of a general deterioration of the grain *. Moral causes have not even been mentioned as contributing to the production of the disease. No unusual circumstances have existed to produce them; and the apathy of the Indian character renders the great mass of the victims of the disease peculiarly exempt from such agency. Their habits and manners appear perfectly unchangeable; for the pictures of them which were drawn in the most remote antiquity answer precisely to the original in the present day.

Contagion, from many circumstances, is a cause whose agency it is more difficult to disprove; but, as far as general opinion goes, it is against the supposition of the disease being propagated in that way. All the evidence which I have obtained on both sides of this question, will be briefly stated in a subsequent part of the work; and it will be found clearly against the opinion of its infectious nature. The decision of the question is less necessary here, as it is admitted that contagion alone is inadequate to the production of an epidemical disease. But the influence of contagion in this epidemic may at once be entirely denied, on the sole evidence of its most extensive ravages on the first day of its appearance at a place,

* It is, however, extremely worthy of inquiry, how far damaged rice has contributed to produce the epidemic. Dr. Tytler supposes, that the grain acquires its injurious properties from being exposed to excessive rain whilst growing; and consequently it is the autumn or *ouse* crop (that which is cut after the rains) to which he attributes the disease. He has given notice of having a work on the subject in the press; and, from his known abilities, I have no doubt that he will show that this cause has in some instances had considerable influence.

and its entire disappearance in the course of a few days; as in the instance already mentioned of the 34th regiment, and many others which might be adduced.

It appears, therefore, that none of the causes that have been mentioned have had any general influence in producing or propagating this disease, except the peculiar condition of the atmosphere, which, in spite of the bias which we always feel to attributing effects to known, rather than to unknown agents, has always been considered as a principal cause of epidemical diseases.

On the supposition, then, that this epidemic depends upon some deleterious state of the air, we are naturally led to expect that its presence should be pointed out by other marks besides the destruction of human life; and it is evident that our principal hopes of success in this inquiry into its nature, must depend on ascertaining the *meteorological occurrences* which have accompanied the disease.

It is also evident, that the chance of arriving at any well-grounded conclusions on this point must depend, not only on the facts themselves, but on the ordinary regularity of the seasons of the country, by which any deviation from it may be more readily and certainly detected; and on the degree of violence with which the epidemic prevails, and the suddenness with which it appears and disappears, by which we are enabled to fix precisely on the periods of these occurrences. In all these and many other respects, it must be confessed that we possess great advantages on this occasion over preceding inquirers into the causes of epidemics; for the seasons and the winds in this country run their course with a regularity which is unknown in temperate climates; the disease usually appears very suddenly, probably more so than any other epidemic, and its decline or disappearance is equally well marked; it usually remains with severity but a few days at a place, at one time, and returns again and again in the same way as at first. In this manner it has prevailed over an immense tract of territory, where it has been exposed to the notice of a very

great number of competent observers, whose *duty* it is to ascertain and report upon circumstances connected with the health of persons under their charge; and thus it has continued for upwards of two years, and still continues to prevail. From these opportunities of investigating its connections, Europe has a right to look to India for some precise information regarding the cause of this formidable disease, which may throw a light on those of other epidemics. These preliminary observations have, however, been made merely to show what may be expected from assiduous and united observation; and I trust the reader will not form on them his expectations of the comparatively few and insulated facts which I have to offer on this important part of the question. But the subject is not likely to remain long in its present obscurity; for we are led to hope, that the official observations of all the medical officers of the Bengal and Madras Establishments regarding it, collected and weighed by the highest authorities, are about to be published, in addition to those which have already appeared from Bombay; and it is also to be hoped, that these invaluable documents will be rendered universally accessible, not only to the Indian but the European public.

CHAP. VII.

OF THE METEOROLOGICAL OCCURRENCES ATTENDING THE EPIDEMIC.

THE slight epidemical attacks of mild cholera which are frequently experienced in Europe, have commonly been observed to be connected with remarkable changes of various kinds in the weather; and Sydenham particularly observes, that heavy falls of rain are frequently attended by these visitations. The most received opinion regarding the cause of the Indian epidemic (if any opinion on the subject can be said to be received) is consonant with this experience; for it has commonly been attributed to the great quantities of rain which have fallen in the country for several years back; and it has been generally remarked, in connection with this question, that the late monsoons (or rainy and stormy seasons) have not only been unusually violent, but irregular; the rains being frequently wanting in their usual seasons, and appearing in abundance at unusual periods.

The disease first began in Bengal in August 1817, at the very height of the monsoon; and, as we are informed by the author of an ingenious article in the Asiatic Journal for May 1818, when the country about Jessore, where it appeared, "was covered with sheets of water from the late heavy rains." He adds:— "The present rainy season (1817) has been one of unusual length; and throughout Bengal there has been no considerable intermission between the falls of rain. Observations by a hygrometer would probably show,

that the general state of moisture during the season has been much beyond the usual average." The Calcutta Government Gazette of November 6, 1817, also states: "The extraordinary rainy weather which has prevailed lately at the presidency seems to have been common throughout Bengal, and has extended its uncomfortable gloominess to the upper provinces." These facts are farther established by Dr. Tytler, for he informs us, that "a perfect deluge" occurred in Bengal in the year 1817.

I have obtained very little information concerning the prevalence of the disease in Bengal, but it appears to have been during the protracted state of the monsoon above mentioned, that it made its early extensive ravages in that part of the country; and that it ceased in a great measure during the fine, cool, and clear weather which prevails in December, January, and February.

It appeared on this establishment with the south-west monsoon of 1818, about the beginning of June; and committed by far its greatest ravages in those parts of the establishment which are subject to that monsoon (the northern and western), and on the whole of the Bombay Establishment, in the months of July, August, and September; which compose the principal part of the rainy reason all over India, excepting the Carnatic, and other countries about the Coromandel coast. There it did not prevail till October, when the north-east or Carnatic monsoon sets in; and it continued throughout these districts in its principal violence during that and the two following months, which compose the rainy season of that part of India; whilst the northern and western parts of the peninsula, where the rains are over in November and December, were then comparatively free from it. It must, however, be observed, that the Carnatic in this year experienced a very large portion of the south-west monsoon, great quantities of rain having fallen at the unusual periods of June, July, and August, but unaccompanied by the disease. This year was also everywhere marked by excessive quantities of

rain. During this year (1819), though the disease had previously spread itself over the whole country, its prevalence has been much less than in the preceding year, particularly during the first three months; for in this period, which is generally accompanied by clear and fine weather all over India, it was little heard of. Since the setting-in of the south-west monsoon it has again been committing great ravages in various parts, especially in the southern regions of the peninsula.

These collective remarks, as applying to extensive countries, and large periods of time, will, however, doubtless be liable to many exceptions, though I am confident their general import will be found consistent with truth. I will now proceed to those in which greater precision is attainable; and detail, as far as I have been able to learn, the state of the weather at each particular time and place of the attacks of the epidemic; without selecting instances to suit a particular theory, but faithfully presenting the whole of the facts bearing on the subject, which have come to my knowledge. It will be necessary to premise, that the rainy seasons in India are far from being accompanied by incessant rain or disturbed weather. They are usually marked by series of very heavy showers, attended with strong gusts of wind, and following each other in quick succession for a few days at a time; leaving long intervals of cloudy and fair, and very frequently of the most serene weather, which continue until the new or full moon, or other causes, bring returns of the rains.

The Calcutta Government Gazette of the 26th of March 1818, mentions, that four thousand four hundred and ninety-three cases of the epidemic had occurred within the town and suburbs of Calcutta during the preceding five weeks; and in the next paragraph informs us, that "storms of thunder and lightning had been unusually frequent and violent for the last week. On Friday evening Calcutta and its neighbourhood were visited by a *north-wester*, accompanied by considerable rain, and thunder and lightning." Several in-

stances are related of much damage being done by this storm.

Some cases of the epidemic appeared at Vizagapatam in May; and Mr. Rogers reports to the Medical Board at Madras:—"The temperature of Vizagapatam for the whole of May varied from 92° to 100°; and from the humidity of the climate this was felt to be extremely oppressive."

The severe attack which was experienced by the Bengal and Madras troops at Nagpore, occurred at the end of May 1818: on the 10th of June the rains appeared with great violence, when the epidemic abated, and immediately afterwards ceased. Of the state of the weather before and after the 10th, I have not met with any account.

The disease appeared at Jaulnah in the beginning of July; and Mr. Peyton, the superintending surgeon of the force, in an official report, mentions, that "the weather at the time was cool and cloudy. The thermometer at noon has not averaged above 88°, and did not vary more than 4° in twenty-four hours. There were some showers of rain, and the clouds have been, until these two days past, low and threatening rain. We have now more sunshine, although the thermometer is not more than 87° at two o'clock. The disease now begins to give way a little; during the last two days the admissions have not been so numerous." It appears, then, that the abatement of the epidemic took place at the same time with the clearing up of the weather. Mr. Peyton attributes the disease to some noxious quality in the atmosphere.

The disease prevailed at Seroor chiefly in the latter end of July. Mr. White reports (28th of July), "Since the epidemic showed itself, the days have been exceedingly close and sultry, and about sunset a piercing cold wind has set in from the south-west." Another report (30th of July) mentions that a few showers of rain had fallen. A third, dated the 3d of August, says that great quantities of rain had occurred. The Bombay Courier of the 1st of August, states: "We are informed that no rain had fallen at Seroor, when

the epidemic made its appearance. The cattle were dying for want of forage. We fervently hope that a favourable change will take place in the weather; and that the new moon of the 2d of August will bring with it an abundant fall of rain." This was precisely accomplished, as shown above. It appears therefore that the commencement of the epidemic here, as well as at Nagpore, had preceded for some days the heavy rain. Similar circumstances will frequently be found to occur in subsequent instances; indeed it appears, that the close, sultry, and oppressive, though dry weather, which immediately precedes the setting-in of the rains, as it does a common thunder-storm, is equally or even more conducive to the production of the epidemic with that which is attended by the heaviest rain; circumstances which at once prove the connection between *the cause* of rain and the cause of the disease, and show that simple moisture of the air is not the deleterious agent.

At Punderpoor, where the disease appeared nearly at the same time as at Seroor, it is reported that the weather, during its prevalence, was sultry and rainy.

Mr. Coats reports, that in marching through a part of the country where the disease was prevailing, he met with daily showers, and on some days the rain was heavy. He particularly remarks that at Nassick, where the epidemic was raging with great violence, the weather was raw and wet during his stay there.

In the same work, Mr. Craw observes:—"I had two or three hundred cases of cholera in the last rains (1817) at Caranja" (near Bombay).

The epidemic appeared and prevailed in its greatest violence at Bombay in the latter part of August. Mr. Jukes, who was stationed at Tannah, on the island of Salsette, and about twenty miles from the town of Bombay, in a letter to the Medical Board observes:—"In order to afford you every information in my power I will just add, that to common observation there has been nothing very particular in the state

of the weather. The barometer has neither been particularly high nor low. The thermometer, for the last month, has scarcely ranged more than from 75° to 82°, and many days nearly stationary at 78° or 79°. Leslie's hygrometer, according to the days, has ranged from 8° to 20°. The fall of rain in August was unusually great; measured by Howard's pluviometer, we had upwards of forty-eight inches*." Some idea may be formed of this enormous quantity of rain, when it is recollected, that even in the rainy climate of Great Britain, not more than thirty-two inches, on the average, falls *annually*†. The Bombay Gazette of September 30 likewise mentions, that thunder-storms of unusual violence had occurred there of late. Accounts from Surat and Broach‡ also lament the damage done there by the "unusual fall of rain" in August.

The Madras Courier of September 8, has the following paragraph: "The floods still continue so as materially to impede our inland communications. The fall of rain during the last two months at the Presidency, has been unprecedented, and yet the rain continues to come down in torrents. Letters from the northward which we have received, pathetically describe the damage that has been sustained in the neighbourhood of the Godavery, which has overflown its banks to a dreadful extent, carrying ruin and destruction to villages, cattle, and the revenue for miles around. On the opposite side of the Peninsula, where much alarm had been excited by the long and unusual drought, for the season of the year, which has prevailed, the periodical rains have fallen in equal abundance, and have occasioned also much damage by the overflowing of the rivers."

A letter, dated September 1818, published in the Asiatic Journal, mentions:—"The Ganges has risen higher this sea-

* Reports, p. 113. † Robertson on the Atmosphere, vol. i, p. 221.
‡ Indian Hurkaru.

son than it has done for many years, and it is more like a sea than a river; there are hundreds of villages completely inundated and deserted." It is also mentioned that uncommonly high tides in the Hoogly occurred in August.

I have been personally informed by an intelligent officer who witnessed the different attacks of the epidemic in Brigadier General Smith's force, at Seroor and other places, that they were *always* accompanied by a cloudy, overcast state of the sky, sudden showers composed of large drops of rain, resembling those of a thunder-storm, and a thick "heavy" state of the air, giving it a *whitish* appearance; and whenever the weather cleared up the disease disappeared. He particularly observed, that the epidemic was invariably preceded and accompanied by a large black cloud hanging over the place; and added, that this had been universally remarked, and that the appearance had even received the name of the *cholera cloud*. All these remarks were made without any questions or suggestions from me which could influence their tendency*.

Mr. Peyton reports to the Medical Board of Madras, that the rains had fallen very heavily between the 7th and 24th of August; and that during this time the cholera had re-ap-

* The coincidence between these observations and the following, regarding the sweating sickness, is very striking:—"Caius Brittannus has observed that some thick clouds, and stinking unwholesome fogs, brought by the wind from the county of Salop, spread this epidemic disease over all England. For from its first origin, both a violent noisome smell preceded the distemper, and a *black cloud* was seen to move from place to place, as it were at the pleasure of the wind, and the pestilential disorder was observed to follow exactly the rout of the cloud."—*Swieten's Comment*, vol. xvi, p. 21.

Van Swieten quotes an author, who alleges that he has himself observed a similar phenomenon "over a town which was shut up on account of the plague, and that both the inhabitants and guards affirmed that it was always there." He likewise quotes similar observations from others.

peared among the troops on their march from Jaulnah to Akowla; which he attributes to the men being exposed to the wet.

The disease appeared at Hydrabad about the beginning of August. I have not met any particular account of the state of the weather at the time, but it is incidentally mentioned that heavy rains occurred there about the 17th.

It appeared in Brigadier General Pritzler's force at Hoobly about the middle of August; and Mr. Scarman, the staff surgeon to the force, reports:—"The disorder has appeared in camp while a strong wind prevailed from the south-west, with heavy clouds and rain." I am well informed by eye-witnesses, that excessive quantities of rain fell during nearly the whole of its prevalence on that occasion.

The disease prevailed at Hurryhur from the 12th to the 24th of September; and it is reported officially by an officer stationed there, that the weather, at the time, was "damp and misty." I have lately met this gentleman, Captain Willows; who informs me, that much drizzling rain occurred during the time that the disease prevailed, and that the weather suddenly became very bright and clear when it disappeared. He also mentions, that an inundation of the Tomboodra at Hurryhur took place in the south-west monsoon of 1818, such as the oldest inhabitant of the place did not remember, and swept away an angle of the fort.

It appeared at Bellary about the middle of September. The weather during its prevalence was extremely unsettled, usually cloudy, squally, damp, and rainy, but occasionally clearing up suddenly, and as suddenly presenting again the former appearances.

The disorder appeared for the first time in H. M. 34th regiment (excepting one case) on the 21st of September, and committed dreadful ravages before night. It is therefore evidently of the highest importance to ascertain the state of the atmosphere on that memorable day. Mr. Allardyce, the surgeon of the regiment, reports to the Medical Board:—"Dur-

ing the whole of the day of the 21st, the weather was unusually close and excessively oppressive, with a clear sun. At 10 P. M. we had a violent thunder-storm, with two hours incessant and heavy rain. It rained again heavily the whole night of the 22d. The 23d was hot and close, but no rain fell at our camp on that day, though a considerable quantity fell all round us. It rained again on the morning of the 24th, and very heavily the whole of that night." On the 25th the disease abated remarkably, and in three days more entirely disappeared. I am not particularly informed of the state of the weather after the 24th, but it is generally mentioned that "it became fine when the disease disappeared."

H. M. 69th regiment suffered severely from the epidemic on their march from Bangalore to Cannanore in October; and met with excessive quantities of rain at the time, which was such as to oblige them to halt for many days. The surgeon of the corps reports (25th of October), "the weather has been most severe during the whole march, and for the last thirty hours the rain has fallen in torrents, and almost without intermission." The disorder was prevailing at this time with great severity.

On the 16th of October the disease broke out very suddenly and with great violence, in a detachment under my charge, near Bellary, in the night, and in the midst of a violent thunder-storm, with heavy and continued rain.

Mr. Duncan reports from Arcot:—"This dreadful malady, which appeared in the depot on the 14th of October, broke out on the same day that the wind changed to the monsoon quarter, the north-east. The weather was variable, with sudden squalls of wind and torrents of rain; the sun very seldom made its appearance, and there was a peculiar chilly sensation from the atmosphere, although the thermometer did not fall lower than 74° in the middle of the day. No abatement of the disease took place till the 23d, the day following a dreadful gale of wind accompanied with rain, which blew from the south-west."

A severe attack of the epidemic was experienced at Colar in Mysore, in October; and on inquiry of the Cutwal, or police officer there, I was informed that it was accompanied by great quantities of rain, during eight days which it lasted; and that the weather became fine when it disappeared.

Mr. Searle reports (November 29), from Manantoddy in Wynaad:—"It gives me great pleasure to inform you, that the epidemic cholera, which paid us a short visit of about six days, has quite left the district. The first case which occurred here was a sepoy, who was attacked on the road, on the 11th of October. No other case occurred till the 16th; which was a most wretchedly comfortless, cloudy day; a strong easterly cold wind blew the whole of the twenty-four hours, and the five succeeding days. The weather remained in the same state during these six days. It cleared up on the 22d, and since then it has been fine, with the exception of a day or two, when we had a mild fall of rain." The disease seems to have disappeared entirely on the 22d*.

On the first appearance of the disease at Madras, Mr. White (then superintending surgeon of the Presidency) reports to the Medical Board: "Considering the low and swampy parts of the town where most persons reside who have been attacked with it, I am inclined to attribute it more to local causes, from the great quantity of rain which has fallen, than to any poisonous state of the atmosphere."

Mr. Mackenzie, surgeon to the Governor's Body Guard, observes, in a report to the Board (13th of October):—"It is a question (notwithstanding the protracted prevalence of the epidemic in various parts of India) as yet undetermined, what

* Since the above was written, I have conversed with Mr. Searle on the subject; and he informs me, that "the weather, during the whole of the six days in which the disease prevailed, was dark and overcast, and extremely dispiriting and oppressive to the feelings; and that at the conclusion of that period a considerable fall of rain took place, after which the atmosphere became clear, bright, and exhilarating, and the disease disappeared."

its predisposing causes are. Various opinions have been given, but all of them admit of unanswerable objections. That, however, some peculiar state of the atmosphere has influence, as an exciting cause, is generally admitted. In this part of the country one circumstance has struck all classes of people—the very great change in the state of the weather which has marked the present year. From June to October, thirty inches of rain are stated from good authority to have fallen, when during the same period in former years from three to five inches have been the average quantity. Added to this material change in the seasons, the atmosphere has, during the same time, been charged in a greater or less degree with electric fluid, and thunder-storms have succeeded each other almost in nightly succession. The thermometer has shown, during the year, a greater alteration in heat and cold than has been known for a long time."

On the 24th of October, when the epidemic was at its height at Madras, a hurricane, unprecedented in violence for many years back, occurred there, which did great damage to the shipping in the Bay, and was felt, within a few hours of the same time, in many other parts of the Peninsula. After this event the weather at Madras cleared up, and the epidemic abated. "The weather since the storm has been uncommonly fine for the season—latterly resembling that after the monsoon. This is a most gratifying circumstance, both on account of the shipping as well as its having afforded an opportunity for repairing much of the damage done on shore. Hopes were entertained that the change in the atmosphere produced by this visitation would have favourable effects with regard to the epidemic; these hopes appeared to have been realized; as we are happy to find, that in parts of Madras where there were numerous cases ten days ago, there are scarcely any; and that this favourable change has taken place in consequence of the alteration in the atmosphere produced by the storm, is no unfair conclusion*."

* Madras Government Gazette, November 6, 1818.

The Madras Courier of the 10th of November states:—"The weather for the last week has been unusually mild and beautiful, and the sky perfectly serene. The cholera is fast disappearing." These facts coincide with those which were observed at Arcot; for there a violent storm occurred when the epidemic was at its height, and immediately preceded its abatement.

A letter from Camp in Rajapootana (30th of October) has the following paragraph:—"The rains are at last over, and we have every appearance of an early cold weather this year. The cholera, which has been raging in our camp, has now left us*."

The disease prevailed at Ganjam, as I am well informed, during the rains in November; indeed in this month, in which the north-west monsoon is usually at its height, the epidemic appears to have prevailed generally over the whole of the districts that are subject to that monsoon; and particularly the south-eastern parts of the Peninsula.

The Madras Courier of December 22, says:—"We are concerned to learn, that the spasmodic cholera has made its appearance in various parts of the provinces of Tanjore, Trichinopoly, Madura, and Coimbatore†. We are also informed, that a *second* inundation of the Cauvery has deluged part of the province of Tanjore. We believe the Cauvery was never known to rise so high at this season of the year." The same paper mentions unusually stormy weather for some time previous, in the Bay of Bengal, and to the eastward. An inundation of the province of Guntoor, from the overflowing of the Kistna in the south-west monsoon of 1818,—the very time when that province was overrun by the epidemic—is likewise recorded‡.

Mr. Henderson, medical officer at Negapatam, reports the appearance of the epidemic in that neighbourhood in Novem-

* Asiatic Journal.

† The disease overspread these provinces in November.

‡ Calcutta Journal.

ber; and states that they experienced a continuance of damp and rainy weather at the time.

Mr. Sladen likewise reports from Salem, that the disease appeared and prevailed there in cold, cloudy, and rainy weather, in November.

The Calcutta Journal of December 8, mentions:—"The epidemic has attacked with considerable violence the troops in the Deccan, which were on their march. This was attributed in a great measure to several days of severe rain, and consequent exposure of the men on the damp ground. Since the weather had cleared up, the disease was becoming much milder and much less frequent in its appearance."

The editor of the Madras Goverment Gazette (astronomer at Madras) informs us, that "the actual fall of rain there from June to December 1818, has been seventy-six inches; which, with one exception, greatly exceeds the annual fall during the last twenty-seven years. The greatest annual fall which we have seen on record is eighty-one inches (in 1791); whilst the average fall since 1791 does not exceed forty-eight, and latterly it has been some inches less."

During the ensuing fine season of three or four months, the epidemic appears to have been extremely rare; and the next attack of it which I have to record evinces its connection with disturbed states of the atmosphere, still more strongly, if possible, than any of the preceding. It occurred in a part of the 84th regiment under my charge, whilst marching in the southern Mahratta territory. The weather in that part of the country, for the preceding four months, had been uninterruptedly serene; for during the whole of this time I had not (to the best of my recollection at the time) witnessed a single shower of rain, or a cloudy day, and certainly not more than two cases of cholera. On the forenoon of the 14th of March 1819, the first case of this attack occurred, and was followed by others in the evening; in the afternoon of the same day the sky became obscured with thick black clouds, and in the evening a considerable quan-

tity of rain, thunder, and lightning occurred. During a continuance of the same kind of weather for the next two days, numerous cases occurred; the fourth day was fine, with a steady strong breeze, but still cloudy about the horizon; and on this day the epidemic ceased.

About a month afterwards General Pritzler's force suffered another very severe attack at Gudduck; and I am informed by several persons who witnessed it, that the weather during its prevalence was very cloudy and cool, the air moist, "as in the monsoon:" certainly very unusual occurrences in the middle of the hot and dry season, as this was. Thunderstorms are also stated to have occurred in the evenings.

The following is an extract from a letter dated Meerut, 21st of August, 1819, and published in the weekly papers. "Heavy rain has fallen since the 17th, before which the weather was very disagreeable. The cholera is, I am sorry to say, making terrible havoc among the King's 14th; within the last week that corps has lost nearly thirty men. We thought the change in the weather had lessened the violence of the disease on the 19th, but yesterday it was as fatal as ever." Another letter mentions that this was the *setting in* of the rains at that place.

The Oriental Star of July 10, remarks: "The commencement of the rains in the upper provinces (of Bengal) has been accompanied by storms of more than usual violence; indeed the whole of this quarter of the globe appears to have been for some months past subject to the most severe and heavy tempests*."

* The following are brief descriptions of two of these storms. These awful visitations of nature acquire additional horrors from the reflection that they are closely connected with another scourge, compared to which they themselves are almost harmless.

"A letter dated Kakadoo, near Cawnpore, the 16th of June, and published in the last India Gazette, gives an account of a dreadful hurricane which occurred at that place on the preceding day.

"'Yesterday afternoon, about four o'clock, as we were all sitting at

A similar general remark occurs in the Calcutta Journal, November, 1818. " Penang.—The latest papers from this quarter speak of very boisterous weather, almost equal to that which has been recently experienced at Madras and Ceylon. The whole of the globe seems to have been visited by unusual convulsions of the elements in different quarters; since we hear from Europe, Asia, Africa, and America, of

dinner, it changed suddenly from the most brilliant sky to an awful gloom, almost amounting to darkness: it was then perfectly calm: but ten minutes had not elapsed, ere a tremendous hurricane of wind arose. In the space of half an hour, every door and window in the Bungalow was burst open, and shattered to atoms; the roof was torn off, and we were all obliged to take shelter in the cook-room, which fortunately was a pucka-roofed building, where we remained till this awful visitation of nature had subsided, when the scene around us was truly lamentable. The river was covered with wrecks of cotton and other boats, which were all entirely lost, and sorry am I to add, that most of the dandies aboard perished. At our ghaut, out of nineteen boats lying there, three only were saved.'—*Calcutta Government Gazette, July* 2, 1818.

Extract of a letter from Gurrawarrah, dated 18th July, 1819.

" We have had at this place a very violent storm, which commenced a little before six o'clock, on the evening of the 17th instant, and was the most tremendous that I have ever witnessed, accompanied with thunder and lightning. Lieutenant H., 2d battalion 27th N. I. was struck by the lightning and knocked down, and also a servant who was standing behind him, but not hurt. His Bungalow was burnt to the ground. At the same time one of the kotes of the 2d battalion 15th N. I. was also on fire; the kote Havildar killed on the spot, as also a Behishtee who was coming from the Bazaar. The rain and hail came down shortly afterwards in torrents, but fortunately not attended with much wind, otherwise some other Bungalows might have suffered from the spreading of the flames. At about half past seven o'clock all was quiet until nine o'clock, when the storm recommenced, and it rained and blew incessantly till nearly midnight, with thunder and lightning, though not so violent as before. It then cleared up, and no farther damage was done to the cantonments. Report says that twelve men were killed on the same evening at Singapore, and four at Nursingpore, the former of which places is about four miles from this, and the latter close to us. I am also sorry to say that a sipahee of the 2d battalion, 27th N. I. was drowned in the nullah this morning."

earthquakes, inundations, and tempests, that have extended their destructive ravages equally by sea and land."

A letter dated Umruttee, September 1, mentions: "We have had a very severe visitation of the cholera during the heavy rains and winds from the south-west*: but it is rather remarkable, that when the wind comes round and blows from the north-west and northerly, there appear few or no cases during these days; and latterly we have had only perhaps one or two cases in a week, and are in hopes the weather will clear up, as we have a respite of rain since the 28th."

It has already been remarked, that the epidemic appeared at Arcot on the very day that the north-east monsoon of 1818 set in. In the present year (1819) that place has exhibited another proof, equally strong, of the connection between the disease and the rainy seasons. During all the early and middle parts of the year, Arcot suffered but in a very slight degree from the disease, but on the appearance of the rains in the end of October and beginning of November, it experienced a very severe attack. The quantity of rain which fell at the time is described as unusually great. The weather for some days previous was extremely close and sultry.

A paragraph in the Asiatic Mirror of the 15th of June states: "The monsoon appears to have set in with peculiar violence at the head of the bay, several outward-bound vessels having been obliged to return with considerable damage. Much sickness is said to prevail among the ships in the river; but whether the disorder be of that kind which is usually called the cholera morbus, or some other, we are not furnished with the means of ascertaining." Other paragraphs state that the epidemic was raging with peculiar violence at Dinapore (in Bengal) on the 18th of June, and in vessels on the Hoogly on the 22d.

In July, September, and October, 1819, I have witnessed a considerable number of cases of the disease at various places;

* That is, the monsoon quarter.

and always in moist, cloudy, rainy, and disturbed states of the atmosphere.

A letter from Moorshedabad, dated 20th November, states, "During the evening and greater part of the 14th, we had heavy rains, and the 16th was showery; since which the weather has been variable. The cholera morbus is making dreadful ravages in the city and its vicinity*."

If to this mass of positive evidence be added the negative proof, that in all my experience, and in all the researches which I have made into this part of the subject, I have not met with *a single instance* in which the disease is found or stated to have appeared in the serene and settled weather which usually occupies so large a portion of the year in India, to such an extent as to be termed epidemical, surely its connection with the opposite states of the atmosphere cannot longer remain in the smallest degree doubtful†.

* Calcutta Journal.

† Since the above was written, I have met with two more accounts of the weather during the prevalence of the disease. A letter, which appears to have been written in the autumn of 1817, mentions: "The rains have been exceedingly heavy hereabouts, and the inundation unusually high this year. I believe the town of Nattore, in the course of last month, was nearly under water, and soon afterwards we had very hot weather. A hot moist atmosphere and the immoderate use of sable fish appear to me to be the principal causes of the disease." A former part of the letter describes the severe prevalence of the disease in the neighbourhood. The epidemic showed itself at Chuprah, on the Bengal Establishment, on the 13th September, 1817; and a letter dated the 22d of that month informs us, that the weather, for a month previous to the latter date, had been excessively hot, with heavy dews at night, but without a drop of rain; another of the 23d, however, mentions a shower. It is added, that "the disease having shown itself at Chuprah after excessive drought, and Bengal in the midst of continued rains, sets at defiance all theories resting on the state of moisture or dryness of the atmosphere."—*Asiatic Journal, May*, 1818.

It appears, therefore, that the disease had prevailed there nine days without rain; but this evidence is not conclusive, until it shall be shown that heavy clouds and other indications of impending rain were not

The observations on the state of the atmosphere in former appearances of this epidemic lead to the same conclusion.

Mr. Curtis observes, that the weather, during the attack which he witnessed in 1782, was "rough and blustery."

The epidemic appeared at Arcot in September 1787; that is, shortly before the setting in of the monsoon*. Mr. Duffin reports, that "a moist and warm atmosphere prevailed there all the month of September in the day time; and thick fogs, with putrid exhalations from the filth which shamefully abounds at Arcot, arose every evening, attended towards morning with cold, heavy dews." Mr. Davies also attributes the disease to the extraordinary seasons, and adds, "we have every reason to wish for the setting in of the rains, which alone can relieve us from the noxious miasmata."

Mr. Corbyn describes an epidemical attack of this disease which he witnessed among the lascars on board an Indiaman in the passage from England to the Cape of Good Hope in 1814; and ascribes it to "severe and tempestuous weather in the Bay of Biscay and at the Madeira Islands, with continual showers of rain and violent hail." It is very remarkable that it occurred in January, and in intensely cold weather†.

In "Porter's Journal of a Cruize in the Pacific," an account is given of a remarkable epidemical attack of this disease, occurring on board his vessel at sea near the Brazils. For some time previous the weather had been very fine, but "from the 19th to the 26th (January, 1813) it was squally with heavy rains. The whole of the 26th we had fresh gales. On the 27th the wind shifted to the east, with a heavy head-

present; and that a heavy fall did not immediately follow, and that before the cessation of the epidemic, agreeable to experience in other instances.

* This month, in the Carnatic, is characterized by great irregularity in the winds and weather; being a sort of *interregnum* between the south-west and north-east monsoon winds; or the *change* of the monsoons. It is usually sultry and showery.

† "Treatise on the Epidemic."

sea. An alarming disease now made its appearance among the crew; ten or fifteen of them were suddenly attacked with violent pains and cholera morbus." They all recovered. The various speculations that are entered into regarding its cause, as lead in the rum, fruit, and sudden change from fresh to salt provisions, only show that it was unknown.

Mr. Robertson, in a report of the diseases of Edinburgh, for August, 1808 (already quoted), observes, that in that part of the world they are usually visited, in the beginning of August, by heavy falls of rain, known to the inhabitants by the name of Lammas Flood; and that, in the year alluded to, they had lasted longer than usual. He likewise informs us that diarrhœa and cholera had been extremely prevalent during the month.

It is well known that cholera prevails particularly in the month of August in England. Sydenham asserts that it appears in that month as regularly as swallows attend summer. Thunder-storms and heavy showers (in some degree resembling those of India) are certainly more common in autumn in England, than at other seasons of the year.

States of the atmosphere similar to those which have been described, are constantly observed to depress the spirits, or in some degree to disorder the frame in various ways; and these effects have been more or less felt by almost all persons who have been present at the more severe attacks of the epidemic. During the visitation experienced by the 34th regiment, few of the officers were attacked by the disease, but nearly the whole of them felt the effects of the morbific cause which was acting on their frames — depression of spirits and uncomfortable feelings, debility, want of appetite, nausea, slight disorders of the bowels, and various other ailments were universally complained of. In both the attacks in General Pritzler's force, the same occurrences were observed, and expressed in nearly the same words, — "every one was complaining." In General Smith's force similar observations were universally made; and my informant assures me,

that the effect on his spirits was so evident, that by it alone he was enabled to form pretty correct presages of the state of the epidemic. Mr. Craw observes, during the first attack at Seroor: "There is amongst us all at this station a wonderful predisposition to disease; some are affected with severe headach, pains in the eyes, rheumatism, and spasmodic affections of the neck, loins, and legs; others with pains at the stomach, nausea, griping, pains or twitches in the abdominal muscles, want of appetite, and irregularity in the alvine discharge; and some with sudden catchings in the legs whilst walking, or a subsultus tendinum in the arms and fingers."

Mr. Davies reports from Arcot, during the attack of 1787: "There is something in the air which I cannot describe the sensation it occasions, in the evening particularly, which both officers and men, indeed every one in the place, are sensible of. A cold damp chill pervades the whole body, and a listlessness aud want of appetite are complained of by all."

Mr. M'Cabe, a gentleman whose professional abilities and scientific character are well known, has pointed out to me a remarkable connection which he has observed between the epidemic and the state of the winds at Madras. In order to render this more evident, it will be necessary to premise a brief account of the usual winds and seasons on the Coromandel coast. The north-east monsoon commences in October, with strong and constant wind from that quarter, heavy rain and frequent storms. The stormy weather and rain continue until the end of December, when clear and cool weather sets in, with the wind pretty constant and moderate, still from the north-east. This continues all January and February; and these months are extremely pleasant and healthy. All March, April, and May, the prevailing wind is the south-east, or *along-shore* wind. This wind is rather moist than hot, and is found extremely disagreeable, and particularly enervating to some constitutions *. It is extremely disliked by the

* Reports on the Epidemic Fever in India, p. 30.

natives, who find it produce rheumatism and intermittent fever. On this account they wish for the setting in of the westerly *hot* or *land winds*, to which they are particularly attached. They generally blow from the south-west or west, all the early part of the day, alternating with the sea breeze, which occupies great part of the remainder of the twenty-four hours. They are very dry, and frequently so hot as to raise the thermometer several degrees on its being exposed to them; but they are found to be healthy, and in the opinion of the natives are extremely so. Notwithstanding their heat, they are employed with great success to cool liquids; for their extreme dryness produces rapid evaporation from the surface of the porous vessels in which the liquids are exposed to them. However great the quantity of rain which may accompany them, they are found to prevent that dampness of clothes and furniture which attends rain under other circumstances *. They continue all June, July, and August, and are attended with frequent showers, which are called the *tail*

* The writer of an ingenious article on the climate of St. Helena, in a magazine which was formerly published at Madras, observes: — "During the prevalence of the westerly winds of the coast of Coromandel, which blow with such force and constancy from May till September, overspreading the atmosphere with accumulations of clouds and vapour brought from the western ghauts and coast of Malabar, the air is in a highly parched and arid state, and there is no rain except during the intermission of these winds. At this period, when the sea breeze sets in from the opposite quarter, its first effects are to blacken and condense the clouds and vapours and convert them into rain." Notwithstanding the apparent dryness of these winds, it is probable, as this author supposes, that they contain a great quantity of water; for from the evaporating quality which they possess, they must have taken up much moisture in their passage over the peninsula; and we know that water frequently exists in the greatest quantities in the air without resolving into rain or producing effect on the hygrometer, until some change induces these occurrences. During the long drought in this country, it is evident that the atmosphere must contain immense quantities of water, yet we see no signs of its existence until the monsoons commence.

of the south-west monsoon. In September, when that monsoon is ceasing and the north-east about to commence, the winds are very variable, and continue so until they set in again from the north-east, with the usual storms and rain.

Mr. M'Cabe found the south-easterly wind prevail to an unusual degree previous to and during the attack of the epidemic at Madras, in 1818; attended with great quantities of rain, and a state of the atmosphere extremely distressing to the feelings; whilst the usual westerly winds were almost entirely wanting. In 1819 it has been universally remarked that the westerly winds have scarcely appeared at all, their place being supplied by the disagreeable and unhealthy winds from the southward. And in one remarkable instance it was noticed, that a temporary change of the wind to the westward had a favourable effect on the epidemic at Madras, in that year. Again, in February 1820, it is observed: "The northerly winds have this year commenced to leave us unusually early, and for some days latterly it has blown fresh from the southward, with all the unpleasant accompaniments usually observed about the middle of March, on the setting in of what are usually denominated the 'long-shore winds.' That dreadful scourge, the spasmodic cholera, which we believe has never entirely left us, has become more active in Madras and its vicinity since the change of the weather, and many cases have occurred, chiefly among the native population *."

Similar observations have been made in other parts of the country. The Bengal Medical Board have observed, that "at Mundela a change in the prevailing winds from south and east to west was the forerunner of returning health †."

It has already been remarked, that the disease was found to prevail at Umruttee, with a south-west wind, and to cease when it changed to north-west.

* Government Gazette, 29th February.

† See their letter in the Bombay Work.

The Staff Surgeon of General Pritzler's force reports (April 1819): "At the commencement of the disease a strong easterly wind prevailed, which in a few days changed to the west, after which period the admissions were fewer and the cases milder."

A Calcutta paper of May 1818 informs us, that "about a fortnight before, on the setting in of a southerly wind, fifteen men belonging to a dockyard in Calcutta were suddenly afflicted with cholera morbus, and ten of them died."

Baron Humboldt has remarked, that the yellow fever prevails on the coast of Mexico from the vernal equinox to a little after the autumnal; during which period the south-easterly winds prevail; and is seldom heard of during the remainder of the year, which is accompanied by the north winds. He adds, that since the year 1794 it has constantly appeared when the north wind ceased to blow *.

The author of "Physiologie d'Hippocrates" observes, that epidemics in tropical climates are frequently produced by south-east winds.

It has been very long and generally remarked, that southerly and easterly winds (particularly the former) in Europe are found to be moist, disagreeable, and unhealthy; to attend

* It appears from the following observations, that the northerly winds on these coasts are accompanied with fine weather, and the southerly by the contrary, "At Carthagena, from December to April, the weather is fine with north-east winds, or *brisas*. The remainder of the year is occupied by southerly and westerly winds, called the *vendables*." * * * "The season called winter extends from May to November; during which time there is almost a constant succession of rain and tempests; the clouds precipitating the rain with such impetuosity that the streets have the appearance of rivers, and the country of an ocean."

"At Panama the same periodical winds prevail as at Carthagena. The southerly winds are attended by rain, fogs, and storms; but during the brisas it is quite the contrary; the air is so serene and the coast so clear as to be approached with confidence and safety."—De Ulloa's Voyage, vol. i, pages 41, 86, 122, 150.

epidemical diseases; and to *depress the barometer.* It would appear that they possess the same characters in India. Dr. Balfour has observed that the south-east wind had a very remarkable effect in depressing the barometer at Calcutta *.

Observations on the barometer are, as far as I am informed, entirely wanting to show the gravity of the atmosphere during the prevalence of the epidemic, for that instrument is rarely seen in India, from the difficulty which necessarily attends its conveyance, and the erratic life which is led by the greatest number of the Europeans in the country. But the meteorological occurrences which have been proved to attend the disease, are all those which are usually accompanied by depression of the mercury. Rain in particular appears to be rarely unattended by depression of the barometer. From the following abstract, drawn up from a meteorological journal for the years 1784 and 1785, kept at Calcutta †, it is evident that a sinking of the mercury accompanies the monsoons in India.

1784 and 1785.	Mean Height of the Barometer.	Mean Quantity of Rain in inches.
January	30.08	0
February	30.02	3.55
March	29.95	1.15
April	29.83	5.55
May	29.77	7.8
June	29.58	20.9
July	29.59	13.9
August	29.59	13.1
September	29.76	11.5
October	29.91	1.1
November	29.98	.7
December	30.01	.25

* Asiatic Researches. † Asiatic Researches, vol. ii.

In the four monsoon months, June, July, August, and September, the mean height of the barometer is 29.63. In the remaining eight months it is 29.94; making a difference of nearly one-third of an inch — a very considerable amount within the tropics. We perceive, also, that the quantity of rain increases very nearly in proportion to the depression of the mercury, and diminishes nearly in proportion to the elevation of the mercury. The lowest state of the barometer (29.58), and the greatest sinking relative to the preceding month (.19), occur at the beginning of the monsoon, in June, when by far the greatest quanty of rain has fallen. The highest state of the barometer occurs in January, when no rain fell. The greatest rising above the preceding month (.15) occurs at the cessation of the monsoon, when the rain diminishes from 11.7 to 1.1. In eleven out of twelve instances the barometer sinks as the rain increases, and rises as it diminishes; in only one instance does the mercury sink as the rain diminishes; and in no instance does the rain increase without a correspondent sinking of the mercury. It is also evident that the depression of the mercury attending the rain amounts to a very considerable sum. The mean height of the three most rainy months taken from that of January, leaves .494, or about half an inch. Mr. Goldingham, astronomer at Madras, informs us* that the variations of the barometer there, though smaller, are not less constantly attendant on changes of the weather than in Europe.

These facts are abundantly sufficient to prove, that a very remarkable depression of the barometer accompanies rain in India; and as it has been shown that the epidemic is attended by rain, the inference cannot be denied, that it is also attended by a diminution of the gravity of the atmosphere. The storms, thick clouds, and haziness of the air, which have so frequently been found to attend the disease, evidently lead to the same conclusion; for there are no facts in meteo-

* Government Gazette, October 1818.

rology more fully ascertained, than that these phenomena are accompanied by a low barometer.

The great predisposing causes of all epidemics are probably very similar, if not the same; consequently any information which is to be derived from researches into the causes of these diseases will be in some degree applicable in the present instance; particularly when it relates to other Indian epidemics, and is derived from the most authentic sources.

In the year 1811, a committee of medical officers high in rank was selected by the Government of Madras, for the purpose of inquiring into the causes of an epidemic fever which was prevailing to a very great extent in the southern parts of the peninsula. These gentlemen visited the provinces where the disease had its principal seat, and appear to have performed their task with the utmost zeal and ability. The following are the principal results of their researches, as collected from their published reports *.

1. The disease appeared and prevailed extensively in the autumn of 1809, and in the springs of 1810 and 1811.

2. The years 1804, 1805, and 1807, were remarkable over all the districts where the fever prevailed for dryness, but they were very healthy. In 1808 much more rain fell in these districts than in the preceding years; and was succeeded by uncommon cold winds in January and February 1809. The monsoon of that year was very severe, and that of 1810 extremely so, completely inundating the country in many parts. The months of February, March, and April, are said to be "proverbially dry on the Coromandel coast, but this year (1811) exhibited a rare, unnatural, and extraordinary variation, by heavy rains, accompanied by the still more uncommon phenomena of an occasional north-east wind, and much thunder and lightning." This irregularity of the seasons was, in general, equally remarkable with their intempe-

* Black and Parbury, 1816. Dr. Whitelaw Ainslie, whose name is very familiar in Indian medical literature, was the president of the committee.

rature. Unusual drought had been followed by inordinate quantities of rain and heavy dews at uncommon periods, and excessive heat by unusual degrees of cold.

3. The winds were also found to vary considerably from their usual state during those years. The north-east winds of January and February, the southerly winds of March, April, and May, and particularly the west winds of May, June, July, and August, are all said to have been weaker than usual. The observations which were made on the injurious nature of the southerly winds, and the opposite tendency of those from the west, coincide remarkably with our experience of them in the present epidemic. "The southerly winds were languid and wavering; the most oppressive lulls were frequent, quickly alternating with sudden gusts of bleak air, accompanied with heavy showers from the north and north-east. What was particularly observable in the state of the atmosphere at this time—the period too at which the epidemic raged with the greatest violence*—was a denseness in it, sometimes almost creating a difficulty of breathing; a feeling we had occasion to experience about the middle of April at Dindigul: and we learn from Mr. Hepburn, that at Tinnevelly it was equally remarkable and distressing. There was besides, during these months, a singularly hot, oppressive, and steamy vapour, which rose from the ground, and which gave a sensation not unlike what is occasionally experienced from a crowded assemblage of people in hot weather. The west wind did not begin to blow so early as usual this season, and was by no means so strong as it commonly is, through the whole extent of the four districts. After having commenced, it ceased again towards the end of May, giving place to gentle airs from the east and south-east. In June, and early in July, it was observed everywhere not

* "From every account we have received, we find that the most unhealthy period in all the four districts, was from towards the end of February to the beginning of May:" that is, during the prevalence of the southerly winds.

to be so powerful as usual, and in the Tinnevelly district there were great complaints of its inefficacy, though it has since blown with greater force; and now (the end of August 1811) the climate appears to be nearly what it should be with regard to winds, and to have in a great measure gratified the hopes and expectations of thousands, by changing the constitution of the atmosphere, and almost entirely banishing the epidemic fever. From a due degree of strength in the drying and purifying west wind, we have ever conceived that much benefit was to be looked for. In the Carnatic, where such winds are always dry, epidemic fevers are absolutely unknown,—a fact noticed by Dr. Lind many years ago*."

4. The districts are in many places marshy; and much rice is cultivated in them, which requires to be kept under water. They are bounded on one side by the western ghauts, the great line of mountains which runs down the whole peninsula, and on the other by the Bay of Bengal. Those parts which are situated on the sea-coast suffered least, and those next the mountains were particularly affected. It was the opinion of the natives, that the disease was owing to the mountains. The villages which were situated near marshes suffered excessively.

5. The disease was most prevalent among the lowest classes, particularly at its commencement; and rarely at-

* These winds bear a strong resemblance to the *harmattan* on the coast of Guinea, which blows from the interior in December, January, and February. It possesses the same evaporating properties and salubrity, but in a still more remarkable degree; for in the course of a few days it renders the grass and leaves of trees perfectly dry and friable, and warps the most seasoned wood. At the same time it is found instantly to arrest the progress of epidemical diseases, and to perform surprising cures. During its prevalence it is difficult or impossible to communicate the small pox by inoculation (Philos. Trans. abridged, vol. xv, p. 25). The *kamsin*, or the wind from the deserts, in Egypt, appears likewise to be of a similar nature: it is extremely hot and drying, and Dr. Lind attributes to it the annual cessation of the plague which takes place in that and the neighbouring countries about June.

tacked people in comfortable circumstances, who lived in elevated houses of brick or stone, and did not sleep on the ground.

6. In three out of the four districts in which the fever prevailed, an excessive mortality took place also among the cattle. In the fourth, which is higher and dryer than the rest, this did not happen.

7. The Committee were convinced that the disease was not contagious.

Their inferences are, that the epidemic arose from one general and two local sources:—the great quantity of rain, the great irregularity of the weather, and the want of due ventilation, comprising the general source: marsh miasmata forming one, and the excessive vegetation on the mountains forming the other of the local sources. It is added, that a similar deviation from the usual order of the seasons in the year 1757, in these districts, was attended by a like calamity; an uncommonly tempestuous and rainy monsoon having been experienced in that year, together with a severe epidemic fever.

The late Dr. Heyne, naturalist on this Establishment (author of "Tracts in India"), has observed in a manuscript treatise on the Hill Fever in India: "All epidemics in this country are preceded by uncommon heavy rains and severe lightning. Such was not only the case in the epidemic fever of 1809-10, and such existed before the appearance of the present cholera morbus in Bengal, and now at Madras."

Medical writings are full of proofs, that "a serene and dry air is the most salubrious;" and, on the contrary, that the opposite states are very commonly attendant on epidemical diseases. Huxham, whose abilities and industry in observation entitle him to the highest credit, frequently supports these opinions, and attributes epidemics which he has witnessed to stormy and rainy seasons:—"Quam pluvia fuit, quam squalida tempestas nuperis annis nemo non norit; et totam annum 1734 et 1735, inter perpetuas pluvias et con-

tinua quasi diluvia contrivimus; nec lætis nos solitisque radiis lustravit sol æstivus, nec purgavit aerem hyemale gelu; dum aer interim, mutata quasi prorsus natura rerum, fuit mire quidem tepidus et humidus; maxime hinc lentæ et nervosæ febres ac remittentes atque intermittentes fuere frequentissimæ: * * * * Omnes hæ causæ vim fibrarum enervant*."

Dr. Lind observes, in the West Indies, "shoals of large and ravenous sharks crowding into the harbours, a dark thick cloud to the southward, with thunder and lightning slowly approaching, foretel the coming on of the sickly season, and are the awful preludes of those impetuous torrents, which in a few days burst from the clouds, and cover with water the whole face of the country†." He likewise informs us that the coast of Guinea, notwithstanding its situation near the line, is found to be healthy in the dry seasons; but on the commencement of the heavy rain and storms, which this country experiences in an uncommon degree from June to October, it becomes a perfect sink of mortality.

A most remarkable instance of the state of the atmosphere, which accompanies tropical rain and storms, proving an active cause of disease, occurs in the account of Park's second journey in Africa. "At this place (where they arrived on the 11th of June) they were prevented from pitching their tests by a heavy tornado, which drenched them completely, and inundated the ground three inches deep. The effect of the tornado on the health of the soldiers was instantaneous. Within three minutes after the commencement of the rain many of them were affected with *vomiting;* others appeared as if intoxicated. Mr. Park and all the rest felt an irresistible propensity to sleep, while the storm lasted; and as soon as it had terminated, notwithstanding every exertion to the contrary, fell asleep on the wet ground. This, as Mr. Park

* Treatise on Fever, &c.

† Diseases of Hot Climates, p. 116.

emphatically observes, proved 'the beginning of sorrow.' They had now proceeded only half way on their journey; the rainy season had begun, and next day twelve of the soldiers, out of thirty-five, were sick*."

Many other facts and observations of a similar nature might be adduced from Lind and various other authors, as well as from daily experience; but the general fact of the connection of rain, and disturbed and moist states of the atmosphere, with epidemical diseases, at least in hot climates, is too well known to require even these instances to prove it.

On these grounds an opinion has been formed, that the *moisture* of the atmosphere, singly, or in combination with other agents, is a principal cause of epidemical diseases; and has obtained perhaps a more extensive application and credit than any other which has been framed to account for them. It is probable that this is a considerable cause of disease (though it is entirely denied by some distinguished authors); but in the present instance, the supposition of moisture of the air in consequence of rain cannot serve as the basis of any theory; for the epidemic cholera has frequently been found to precede the falls of rain, whilst the earth was still parched with drought. Nay, so far from the rain being the cause of the disease, it is a very general, and I believe a just opinion, that it actually tends to destroy not only this but other epidemics. Several instances have been already related where the disease disappeared on the occurrence of heavy rain succeeded by fine weather. I have frequently seen the endemic fever of Seringapatam in a very striking manner abate or disappear after heavy falls of rain. This also is consonant with the observations of Huxham; and the following passage, though it exhibits a remarkable apparent inconsistency with that which has just been quoted from the same author, at the same time shows his attachment to truth. "Haud raro hercle notavi post procellas gravesque pluvias

* Campbell's Park's Travels, p. 188.

febres epidemicas multum fuisse imminutas, et vi et numero. Ideo forte dives Augustus cum in Gallia moratur, templum et vovit et fecit Circio, venti vehementissimi; eique turbini, etsi edificia sæpe diruenti, gratias publicas Gens Sallica olim, referente Seneca: utpote cui salubritatem cæli sui deberet*."

The cold, and the great and sudden transitions from heat to cold, which frequently accompany the states and changes of the atmosphere above described, have also been commonly considered as the principal causes of this epidemic; and the tendency of these causes to produce cholera in hot climates cannot be denied. They are not, however, so generally present as to be sufficient to account for the disease. In many instances it is recorded that the weather during its prevalence was merely temperate. In my own experience, neither has remarkable heat, nor cold, nor vicissitudes from one to the other, attended the disease. The attacks are frequently found to precede the change of temperature, as well as the rain which usually gives rise to it. In General Pritzler's camp in January last, the thermometer frequently sunk at night to within one or two degrees of the freezing point, producing a sensation of cold greater than I had ever before experienced, and ice was formed in abundance, with the assistance of evaporation, on the leathern bags in which water is kept; at the same time the sky was perfectly serene, and consequently the sun sufficiently powerful to produce a high temperature in the middle of the day; yet at this time no cholera appeared, though it had prevailed in the camp a few months before, and returned some months afterwards, when the temperature was much more equable. Cholera generally requires a high temperature for its production; but it has been found to prevail at all degrees of atmospherical heat. In many instances it has committed its ravages in the hottest seasons. Mr. Corbyn relates an instance, already mentioned,

* Huxham de Aere et Morbis Epidemicis.

where it prevailed in the northern part of the Atlantic ocean in intensely cold weather, in January. A remarkable peculiarity of circumstances was, however, observed on this occasion, in the Lascars, among whom the disease prevailed, being lodged in a very small and close *berth*.

To the other circumstance which has appeared to attend the epidemic, the depression of the barometer, similar objections cannot be made; for that phenomenon is constantly found to accompany the states of the atmosphere above described, under all circumstances. It is likewise found to *precede* them; consequently the opinion of its connection with the great cause of the disease is supported by those instances of the appearance of the epidemic, which are fatal to other theories. It appears, therefore, that of all the atmospherical phenomena, which have been mentioned as accompanying the disease, none are universally present, except those which indicate a diminution in the density of the air, and a *tendency* to rain and storms.

CHAP. VIII.

OF SOL-LUNAR INFLUENCE.

When the moon,
Closing her monthly round, returns again
To glad the night, or when full-orbed she shines
High in the vault of heaven, the lurking pest
Begins the dire assault.

SOMERVILLE.

NOTWITHSTANDING all that has been said on the subject of the influence of the heavenly bodies on the animal frame, and the firm belief in its existence which has been expressed by many distinguished authors, both of ancient and modern times, that dogma appears to have gained little general credit in the present age. Excepting the valuable pages of Darwin, it is scarcely mentioned as a cause of disease in any modern systematic work on medicine. A late distinguished writer on madness (Haslam), whose opportunities of seeing lunatics must have been very extensive, entirely denies their being affected by the different situations of the moon. In Rees's Cyclopædia, one of the most approved and diffuse modern works on general science, a quarter of a page only is given to the subject of the influence of the moon on the weather, and on the human frame; and this is taken up with denying it *in toto*. "The hypothesis of planetary influence on the human body has originated and passed by with the age of astrology!" In the Encyclopædia Britannica (1810), the little attention which has been paid to the subject

has led to a singular inconsistency. After repeating the hackneyed and erroneous remark, that "as the most accurate and sensible barometer is not affected by the various positions of the moon, it is not thought likely that the human body should be affected by them," they proceed in the next page to furnish a complete mass of evidence, that *the barometer has been found to be very remarkably affected by the various positions of the moon.*

I am, however, aware that these imperfect notices do not express correctly the general opinion of the European public on the subject. Sir James M'Grigor expressly mentions that he has observed the extensive influence of the moon in producing disease, both in India and in Egypt*. The large collection of facts in proof of this influence which Dr. Balfour has brought forward, must have produced much conviction. But the scepticism which evidently exists is truly surprising to persons in this country who daily witness the agency of this cause: for I will almost venture to assert, that there is no person in India, who has paid attention to the subject, who will deny that the new and full moon have a very marked influence in the production both of disturbed states of the atmosphere and diseases.

The difficulty of explaining this influence appears to be the great obstacle, which, in modern times, has stood in the way of the belief of its existence and general prevalence. The ancients, who less minutely scrutinized the chain which connects effects with remote causes, implicitly believed in the existence of this power, simply because they saw the coincidence of its effects and certain states of the heavenly bodies; although they knew not that these bodies in other respects exert a physical influence on the earth. But since the progress of science has enabled men to trace more distinctly the manner in which changes arise from and produce other changes, this empirical mode of reasoning has ceased to be satisfactory;

* Medical Sketches of an Expedition to Egypt.

and the improvement of philosophy seems in some instances to have actually operated as a barrier to its farther progress, by furnishing negative arguments against the existence of causes which we are unable to connect by any satisfactory theory with their effects. Every occurrence in nature has been attempted to be accounted for on rational and general principles, and it has been found much easier to deny than to explain the operation of the sol-lunar power.

If, however, these principles were to be applied in all their extent to the other branches of medicine, they would strike at the very root of that imperfect science; for we know little more of the modus operandi by which ipecacuanha produces vomiting, or jalap produces purging, than we do of that by which the new or full moon produce attacks of intermittent fever, of mania, or epilepsy. We have the same kind of evidence of the agency of both these classes of causes; and after the proofs which have been adduced of sol-lunar influence, it would be nearly as preposterous to deny its existence because we cannot account for it,—because it does not produce its effects on all persons,—or because the same occurrences frequently arise without its agency, as it would be to assert that a common dose of ipecacuanha or jalap will not produce vomiting or purging, for precisely the same reasons. It does not, nevertheless, appear to be impossible to make some approach to the explanation of the nature of sol-lunar influence on known principles. It is proved, on the known laws of gravitation, that the various situations of the moon necessarily must have determinate effects on the atmosphere; observations have shown that such is the case; and on these data considerable progress has already been made in the elucidation of this interesting subject.

It appears to be very evident that sol-lunar influence is much more powerful within the tropics than in other parts of the world; and this may in some degree account for the little credit which it has met with: for little information, in comparison to the opportunities which are presented, has been

conveyed from these countries to the native regions of philosophy. Dr. Balfour has indeed been impressed with all the importance of his subject, and even more than all; his situation and experience were such as to entitle his opinions to the highest attention, and he has given them to the world in the fullest manner; but he has failed in gaining complete credit; probably from the dogmatical style which he has adopted, and from his having fallen into the error which is usually fatal to theories—that of aiming at too much.

Our experience in India furnishes instances in abundance, similar to those adduced by Dr. B., of the coincidence of attacks of intermittent fever with the lunar periods. I will adduce two of the most striking of them which at present occur to me:—

Lieut. P., of this establishment, informed me that he had been subject to fever for the last four years. Its first attack was on the 6th of September, 1815, about two days after the new moon. It assumed a remittent form and lasted three weeks, consequently disappearing immediately after the last quarter. In 1817 and 1818, it returned frequently in an intermittent form, and he remarked generally that it made its appearance near the full and change. From January to July, 1819, it recurred regularly two days before every full moon. Each attack consisted of four or five paroxysms, recurring every second day, *viz.* two days before the full, on the day of the full, and the second, fourth, and sixth days after it, thus disappearing at the quarter. The two first paroxysms of each attack were found to observe the solar period; that is, to return at the same hour of the day. The second (that which happened on the day of the full) was usually the most severe. The remaining two or three paroxysms grew gradually slighter, and observed the lunar period; each of them returning, like the tides of alternate days, to which they corresponded, about an hour and a half later than the preceding one.

Mr. R., a gentleman of the civil service of this establish-

ment, informed me that he was attacked with fever at Ganjam, on the 10th of April, 1815; and on reference I find the moon was at change on the preceding night. During the ensuing eight months it continued in an irregular remittent and intermittent form, and always returned at the new moon. For the *whole* of the next two years, it recurred with perfect and surprising regularity; for he had a single paroxysm every lunar month, and that invariably on the day of the new moon.

In my own person as well as practice I have observed many similar coincidences; and in short it appears, that when intermittent fever in India assumes the chronic and recurrent form, at least in persons of regular habits, its returns are almost invariably at the full or new moon.

But although the sol-lunar power is greater in tropical than in temperate climates, it is far from being confined to the former. Dr. Mead firmly believed in the general agency of this influence, and his observations were made in England. The same doctrine is held by Diemerbroek. He relates, that in the plague of 1636, "two or three days before and after the new and full moon the disease was more violent; more persons were seized at these times than at others; and those who were then seized almost all died in a very few hours, *nescio quâ virium labefactione oppressi.*" The evidence of Rammazini on this head is likewise extremely full and explicit. During the prevalence of a pestilential fever for three whole years at Modena, he observed constantly, that its violence was much greater at the new and full moon (particularly the former) than at other periods; and he adds, that this was a matter of general observation. He remarks in particular, that at the time of an eclipse, a great part of the sick had died at the very hour of its occurrence, and sudden deaths had occurred in persons who were previously in health*. Mead says:—"Nullus dubito, quin si ea, quæ de vi lunari dicta sunt, medicis essent cognita, longe plura in historiis

* Mead, de Imperio Solis ac Lunæ in corpora humana, 64.

morborum epidemicorum, hujusmodi exempla occurrerent quam hodie invenimus."

The commencement of the plague at Malta in 1813* appears in a very striking manner to confirm this opinion. The disease is said to have been carried thither by a vessel from Alexandria. Two men died on board this vessel, at sea, about the 22d of March, 1813. The moon was at full on the 17th of that month; consequently it is probable, from the usual duration of the disease, that they were attacked shortly after that event. The crew continued healthy until the 1st of April, when two of them were attacked in the Lazaretto at Malta with the plague, and shortly afterwards died. The moon was at change on that day. A period of nearly half a lunation then elapses without any fresh attacks occurring. On the 13th or 14th a person in the city is attacked. The moon was full on the 15th. It is then again not heard of for another half-lunation. On the 1st of May another person is discovered to be ill with the disease. The moon was at change on the preceding day. From this period several cases occur at irregular intervals, but without exciting much alarm until the 16th of May, when the disease is found to be "developing itself in many parts of the city at the same time." The moon was again at full on the 15th.

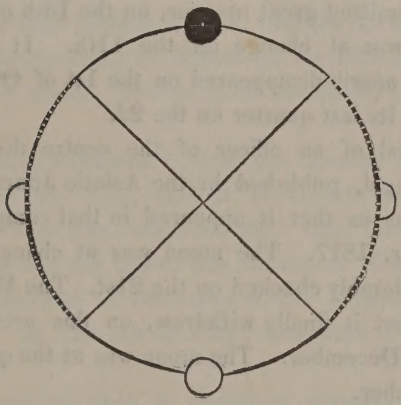
On perceiving the analogy between the cold stage of fever and cholera, I was led to suspect that the epidemic might be influenced by the moon; and on collecting all the dates of the appearance of the disease at particular places, which were then within my reach, I found that nearly the whole of them had occurred within a short period of the full or change. These observations were offered to the public in a letter, published in the Madras prints, in November, 1818; with the view of exciting attention to the subject, and producing such extended observation as to set the question at rest. I have since collected a great number of these dates; and

* Dr. Calvert's paper in the 6th volume of Medico-chirurgical Transactions.

the coincidences which they exhibit with the states of the moon appear completely to prove, that the various positions of that planet have a marked influence in producing and removing the disease.

I will now proceed to detail the whole of the dates of its appearance and decline at different places, which I have ascertained with any precision, and to compare them with the phases of the moon. And I beg the reader to believe, that I consider the suppression of any instances which are adverse to the opinion, much more any misrepresentation of facts, as a culpable breach of that confidence which every writer hopes to gain in his integrity.

The lunar revolution takes place in twenty-nine days twelve hours nearly, consequently each of its great periods of full and change are distant from each other about half that time, and the quarters, or intermediate periods, are distant about seven days nine hours from the full and change. It is presumed that the morbific influence is greatest about the full and change, and least about the quarters. It will therefore be useful to divide the whole lunation into four periods,



as in the accompanying diagram, with the new and full in the centres of two of them, and the quarters in the centres of the other two; and to consider the two former (marked by black

lines) as the unhealthy periods, and the two others (marked by dotted lines) as the healthy periods. It is then in the former that we are to look for the attacks of the epidemic, and in the latter for its decline or disappearance. Each of these periods consists of nearly seven days and a half, consequently if the appearance of the disease takes place within about three days and three quarters before or after the full or change it is favourable to the theory, and the more so the nearer the full or change. If the occurrence is at a greater distance from these periods (falling within the dotted lines) it is unfavourable, and the more so the greater the distance, and consequently the nearer the quarters. The inversion of the same rule may be applied to the declines.

The first appearance of the epidemic was at Jessore in Bengal; and the Medical Board of Bombay inform us, that it broke out there in the middle of August, 1817. The moon was at change on the 13th of that month.

It appears from an ingenious essay on the disease, published in the Bengal papers, in October, 1817, that it appeared at Chuprah, a large city on the banks of the Ganges, where it committed great ravages, on the 13th of September. The moon was at change on the 11th. It is mentioned that it had nearly disappeared on the 1st of October. The moon was at its last quarter on the 2d.

The journal of an officer of the centre division of the army of Bengal, published in the Asiatic Journal for July, 1818, informs us that it appeared in that camp on the 12th of November, 1817. The moon was at change on the 9th. It was considerably checked on the 21st. The Medical Board inform us that it finally withdrew, on this occasion, in the first days of December. The moon was at the quarter on the 2d of December.

They likewise mention that it appeared at Jubbulpore on the 9th of April 1818. The moon was at change on the 5th.

Mr. Ogilvie reports, that the disease appeared in that city about the 19th of May, 1818, the day before the full moon. It extended to the Bengal troops there on the 30th, and to the Madras troops on the 31st and 1st of June. The moon was at change on the 4th. It abated on the 10th, and disappeared before the 12th. The moon was at the quarter on the 12th.

It is also stated that the epidemic appeared and disappeared among the troops at Hingumghaut, fifty miles from Nagpour, precisely at the same periods as at Nagpour.

The 20th native infantry, on their march in that neighbourhood, experienced an attack which began on the 4th, and likewise subsided on the 10th of June.

The superintending surgeon of the Nizam's subsidiary force reports, that it appeared at Jaulnah (the head quarters of the force) on the 3d of July: the day of the new moon. He adds (12th of July), "the disease now begins to give way a little; within the last two days the admissions have not been so numerous." The moon was at the quarter on the 11th.

It is evident from various reports, that the disease appeared in the large cantonment of Seroor on the 18th of July: the day of the full moon. It abated on the 25th; that is at the quarter.

Captain Sykes mentions*, that the disease appeared at Punderpoor on the 14th, and at Natapoota on the 17th of July. The former was somewhat more than three days, the latter less than one day before the full moon. Official reports state that it appeared in the camp of the Mysore horse, on the Godavery, on the 8th of July; less than five days after the new moon.

Mr. Dean reports that it prevailed severely in Colonel M'Dowel's camp from the 15th to the 25th of July. The

* Bombay Reports.

former period is between two and three days before the full moon; the latter is the day of the quarter, and of its abatement at Seroor.

It appeared at Panwell on the 6th of August*, four days after the change.

It appeared at Bombay† on the 14th of August, two days before the full moon.

The staff surgeon of General Pritzler's force reports, that it had made its appearance among the followers of that camp on the 13th of August. It broke out with great violence among the troops on the 18th: the moon was full on the 16th. This was one of the most fatal attacks which the troops on this establishment have experienced. It commenced and prevailed in its greatest severity at the same time with that of Bombay, though the camp was at a distance of about four hundred miles from that place. On the 14th of August, likewise, the disease first appeared at Ongole, which was about the same distance from their camp on the opposite side from Bombay. Many similar coincidences, which it is unnecessary to point out, may be observed in this collection of instances; and I have no doubt that if sufficient inquiry were made, almost every new and full moon since the first commencement of the epidemic, particularly in the monsoon seasons, would be found to be attended by many of its appearances and re-appearances at distant places.

Mr. Selby reports, that the cholera hospital was established at Hydrabad on the 2d of August, the day of the new moon.

At Narriankary, a large village about half-way between Hoobly and Bellary, I ascertained from a register, that the disease had appeared there on the 1st of September, the day after the change.

* Reports, Preface, p. 9.

† Reports, p. 175.

An officer who was stationed at Hurryhur reports, that it appeared there on the 12th of September (two days before the full moon), and nearly disappeared on the 24th (two days after the quarter).

The epidemic broke out in H. M. 84th regiment at Bellary, on the 17th of September, having prevailed among the native inhabitants some days before. The moon was full on the 14th.

The first case occurred in H. M. 34th regiment on their march from Bellary to Bangalore, on the morning of the 18th of September, but the general attack did not appear until the 21st. It abated on the 25th.

The superintending surgeon of the centre division reports, that it had appeared at Ongole on the 14th of August (two days before the full moon): at Nellore on the 20th of September (six days after the full): and at Tripetty on the 1st of October (the day after the change).

The disease appeared with violence in a detachment under my care on the 16th of October; the moon was full and eclipsed on the 14th. It continued about three days, and ceased about two days before the quarter.

Captain Croker went on a hunting excursion to the Sindoor valley in October; and chose the time of the full moon to enable him to carry on his well-known eccentric operations against wild animals by its light. He arrived at a large village in the valley, and found it free from the disease; but immediately afterwards it broke out with violence; and he is certain that the moon was then just past the full*.

* This gentleman assures me, that he has on other occasions witnessed the appearance of cholera about new and full moon; and that he has long been convinced of the fact of its influence on the epidemic. He has paid much attention to the disease, and has actually opened several bodies on his hunting excursions, to show the appearances to the natives; and to convince them that the liver had not burst from the vomiting, and occasioned death, as they supposed.

Mr. Duncan reports from Arcot:—"The disease commenced here a day before the full moon, and abated immediately after the quarter." It appeared on the 14th of October, and abated on the 23d (by the same report); consequently the attack was on the day of the full, and abatement the day after the quarter.

The disease made its first appearance at Poonamallee (as I learn from Mr. M'Cabe) on the 15th of October; the day after the full moon, and that of its appearance at Arcot. These places are about sixty miles asunder.

The cutwal of Colar informed me, that the disease broke out there at the very commencement of the Mohorrum, or great Moorish festival, which is yearly held on the first ten days of the moon, occurring that year in October. It prevailed eight days, and consequently disappeared a little after the quarter.

The first case occurred at Manantoddy on the 11th of October, and the general attack on the 16th. The former period is three days before; the latter two days after the full moon*. The disease abated or ceased on the 22d, the day of the quarter.

It is reported to have appeared at Cuddapah on the 9th of October; being five days before the full.

Mr. Henderson reports, that it appeared in the city of Nagore on the 10th of November. Mr. Goldie, superintending surgeon, reports its appearance at Trichinopoly on the 1st of November (two days after the change), and that it began to abate on the 23d. The moon was at the quarter on the 21st.

Mr. Sladen reports its appearance on the 19th of November at Sankerrydroog; and Mr. Henderson at Negapatam in

* The attacks which occurred within two days after the full moon in October are five in number; *viz.* two in the ceded districts, and those of Manantoddy, Arcot, and Poonamallee. These circumstances seem to argue that the *eclipse* had some influence.

the end of November. The moon was at change on the 28th.

It has already been observed that the epidemic appeared in a detachment of H. M. 84th regiment, under my charge, on the 14th of March, 1819. The moon was at full on the 12th. It lasted four days, disappearing for a time on the day before the quarter.

In the following month I met with an officer returning from Beejnuggur, where he had been stationed with a party during the great fair which is annually held there. He informed me, that the concourse began on the 7th of April; and that they remained free from the epidemic until the 11th, when it broke out with great violence, and shortly afterwards occasioned the breaking up of the fair. The moon was full and eclipsed on the 10th; and on the 11th, a solitary case occurred with me, about forty miles from Beejnuggur.

The staff surgeon of Brigadier General Pritzler's force reports, that the epidemic had reappeared in their camp on the 15th of April.

I ascertained from a register kept at Conjeveram, that the disease had reappeared there (after having been entirely absent for many months), on the 10th of June, 1819. The moon was full on the 8th. It continued to prevail irregularly, at the average of eight deaths daily, until the 29th. From that period to the 7th of July, inclusive, not more than five deaths occurred in all (the moon was at the quarter on the 30th); but on the 8th, the day on which I was there, it was again increasing, for three deaths had happened. The moon was again at full on the 7th; and on that day a heavy fall of rain had occurred.

On my arrival at Poonamallee, two days afterwards, I learnt from Mr. M'Cabe, that he had had no case of cholera for upwards of a week before the 8th, but on that day many cases had occurred, and were still occurring.

It appears from a paragraph in the Asiatic Mirror, that the ship Mary was first attacked by the disease in the Hoogly, on the 22d of June, 1819; having shortly before arrived from Europe, with thirty-five persons on board, not one of whom had been sick since they left England. "Before the expiration of that fatal day the Mary had eleven men sick in their hammocks and five corpses ready for their graves!" This was the day of the new moon.

Mr. Hewitson observes, in an official report, dated Calicut, the 23d of August, 1819:—"I am sorry to say that the epidemic cholera has increased since the 19th instant. I hope, however, that from this day it will begin to be less frequent; as I have remarked we always of late find it more prevalent on the two days before and after the lunar changes than at any other period." The moon was at change on the 21st.

In a party of H. M. 69th regiment, seven cases only of cholera occurred in the course of their march across the Peninsula, from Cannanore to the Presidency. The first of these was on the day of the new moon in September. Five more appeared between that period and the ensuing quarter; and the seventh on the day of the full moon in October. From that time I met with no case of the disease until the day of the full moon of November, when a slight one occurred in a servant of my own.

The Penang Gazette of the 20th of November, 1819, states: "The cholera may be said to have commenced here in an alarming degree of violence on the 23d of October, though some few deaths by this disease certainly occurred previous to that date. The moon was at change on the 19th; and, if the cases which happened before the 23d are taken into account, it is probable that the disease broke out very near that syzigie.

A letter in the same paper mentions a continuance of stormy weather with heavy rain in that neighbourhood, about

the 25th of October; and the editor observes (20th of November), "The weather during the last week has been as mild as we could wish, and the rain fallen only in occasional showers; and we are happy to state that it has had a favourable effect on the epidemic." Again (4th of December), "The disease is rapidly diminishing, and if the present favourable weather should continue, hopes may be entertained of its speedily leaving the island." Accounts in the public papers likewise mention "almost incessant heavy rains and great sickness," on the island of Java, in October, occasioning the failure of a Dutch expedition against Palambang. The rainy and stormy season of this part of the world is the same with that of the Coromandel coast, but of longer continuance, and commences about the same time, that is, in October or November. This period, then, corresponds to the time of the appearance of the disease at Penang; and in these months it likewise appeared and prevailed extensively in the peninsula of Malacca, and at Acheen and other parts of Sumatra. A letter received by a medical gentleman in Bengal, from a friend at Malacca, which has appeared in the public prints, gives the 30th of November as the date of the appearance of the epidemic at that city.—The moon was at full on the following day.

The following extract from the report of a Medical Committee, appointed by the government at the Mauritius (dated 26th of November, 1819), fixes precisely the date of the appearance of the epidemic on that island. "The first well-marked case of the present disease occurred on the 6th of September last, and was treated by Mr. Trebuschet in Port Louis; it differs in nothing from the cases which have presented themselves since the 18th and 19th of November, and which appeared to break out so suddenly in all quarters of this town."—The moon was full on the 4th of September, and at change at midnight between the 17th and 18th of November.

The committee observe, that unusually great and sudden vicissitudes in the temperature of the atmosphere had been observed when the disease appeared; and exposure to the inclemency of the weather was considered as one of its principal causes.

The rainy season commences there in November and December, and lasts till March; during which period (particularly at its *commencement* and termination) the island is subject to violent hurricanes*. It is evident then, that the disease appeared here also at the beginning of this season, agreeable to our experience in India. Grant, in his history of the Mauritius, gives the following brief notice of the usual state of the weather at that time of the year. "November. The heat is now very sensibly felt; the winds are variable, and are sometimes in the north-east. The rains are attended with storms." It remains to be seen whether the rain and storms of this year do not prove unusually violent there, and whether their connection with the epidemic is not found to be equally evident with that which has been observed in India†. The above-mentioned committee inform us, that "a similar disease prevailed in this island in 1775, *after* a long dry

* It is worthy of remark, that this season perfectly corresponds to the great south-west monsoon of India; for it occupies exactly the opposite period of the year, and prevails under the same relative situation of the sun. The south-west monsoon commences as the sun approaches the northern tropic and is vertical over the peninsula; the Mauritius monsoon likewise commences when he approaches their zenith (near the southern tropic): the former ceases about the autumnal, the latter about the vernal equinox. The winds of the latter are from the north-east and north-west.

† Since the above was written, I have met with an account of the ship *Forbes* experiencing *six heavy gales*, between Madagascar and the Cape, in October, 1819. The ship *Union* likewise suffered a very severe gale, from the eastward, in the Bay of Bengal, on the 15th of October; which nearly corresponds both in time and place to the appearance of the epidemic at Penang.

season, &c.; the symptoms, fatal and sudden effects, and duration, would seem to be exactly the same; *a hurricane put a stop to its ravages*, which continued for probably two months, and caused a great mortality, particularly among the blacks and people of colour." Grant informs us, that the influence of the moon in the production of these storms is so well known, that vessels never remain at anchor at Bourbon about the full and change during the period of their prevalence*.

We are informed, that the crew of the transport *Golcondah* was attacked with this disease on the passage from the Coromandel Coast to the Cape of Good Hope. The time and place are not specified; but it is probable that it happened about the month of July, 1819, and in the neighbourhood of the Cape; as the letter in which the account of it is given is dated at Symon's Bay in that month, and mentions that one person on board was still in danger from the disease. It likewise mentions a *tremendous gale* which the vessel had experienced off the Cape.

Mr. J. Orton writes, from Kaira in Guzerat: "The cholera appeared here on the 1st of this month (February, 1820), and became more prevalent on the 2d and 3d; after this the cases were fewer and slighter, till the 10th and 11th, when it appears again reviving. The weather became remarkably

* A volcano exists in the Isle of Bourbon, and it will be interesting to be informed whether any changes take place in it during the prevalence of the epidemic in the neighbourhood. Webster has observed, that eruptions of volcanos have commonly attended epidemics. A remarkable eruption of the Bourbon volcano took place in 1787; a violent hurricane is recorded as occurring there in that year, and another at Pondicherry. At this time too the epidemic cholera was prevailing in India. In the autumn of the preceding year an earthquake was felt at the Mauritius. Did this or any other epidemic prevail there in these years? Is the hurricane season there more unhealthy than other periods of the year? According to Lind, this season is very unhealthy at Madagascar, which is at no great distance from the Mauritius.

colder on the 2d, and the thermometer did not rise above 70°. On the 3d, a quarter of an hour before sun-rise, thermometer in the open air 39°: hoar frost on the ground, which has killed gram, tobacco, cotton plants, &c. It became warmer on the 7th, the thermometer, on that and the three following days, rising to about 83° in the afternoon. On the 2d there were rather thick clouds, slight drops of rain, and thunder once heard." The last-mentioned occurrences are very unusual at that season of the year. So great a degree of cold is likewise very uncommon, and would appear to be connected with the epidemic*. The moon was at full on the 30th of January. This attack was but slight.

The following abstract presents at one view the foregoing data, regarding the sol-lunar influence in the epidemic (exclusive of single cases and the more indeterminate periods), collated with as much precision as they admit of.

	Days before or after Full or Change.						
	1† or less.	2	3	4	5	6	7 and 7½ (the quarter.)
Appearances.....	16	15	5	5	2	3	0

* It is observed that the cold becomes more intense at Hudson's Bay about the new and full moon.—*Robertson on the Atmosphere*, vol. i, p. 108.

† This column contains the instances which have occurred on the day of the syzigie, as well as the one preceding and following. It appears therefore that the greatest number have happened on the second day from that of the syzigie; and of these much the largest proportion has occurred on the second day *after* the syzigie. The attacks which have commenced in the plenilunar or *light* half of the

It does not appear necessary to produce any further arguments in support of the conclusion which has already been drawn, that the moon's syzigies have a very marked influence in producing the disease, and the quarters in removing it. It may, however, be added, that the fact has been the subject of pretty general observation. Dr. Heyne has remarked, in a work already quoted, "The exacerbations of the epidemic cholera have been of late, and I believe with truth, referred to the influence of the moon." Mr. J. Orton writes to me from Guzerat: "Mr. Jukes had observed the influence of the moon in producing cholera at Tannah, before your letter appeared, but I do not perceive that any account to that effect has been made public. Dr. Meek, superintending surgeon, has made the same observation at Surat: Mr. Wybrow here also." Dr. Balfour has enumerated cholera among the diseases which he considered subject to sol-lunar influence.

It is not, however, to be expected that the appearances of the epidemic will be found to take place exclusively near the syzigies, or its abatements only near the quarters. Sol-lunar influence is doubtless but *one* of the causes producing the state of the atmosphere which gives rise to cholera; and I have no doubt that the disease will often be found to make its appearance when the disturbing power of the sun and moon is least, and to subside when that power is at its height. The lunar syzigies are well known to have a great influence in producing storms and rain, yet these occurrences are far from being confined to those periods, even in tropical climates. The epidemic appeared at Bombay about the full moon, but I must confess that it does not appear, from the registers furnished by the Medical Board, that any considerable in-

month are twenty-eight; those of the novilunar or *dark* half amount only to eighteen. Hence it would appear that the full has had the greatest influence; but further observation is necessary to determine this point.

crease or diminution of it took place at the subsequent syzigies or quarters, whilst it continued to prevail there. It is somewhat difficult to reconcile this to the theory; but we observe something analogous to it in the monsoons of this country. A series of rainy and stormy weather usually *commences* about the new or full moon; but when this constitution of the atmosphere is once formed, it often runs on for weeks, irregularly increasing and diminishing, apparently uninfluenced by the moon, and not unfrequently, like the epidemic, reaching its maximum about the quarters.

The theory of sol-lunar influence likewise accounts for some remarkable circumstances attending the disease, which appear to be inexplicable on other principles—its sudden appearances and disappearances, and the short periods of its prevalence. It is *usually* found to subside, and often to disappear entirely, at particular places, within a few days of the time when it had broken out with the most dreadful violence; and, after scarcely allowing time for congratulation, it frequently makes another sweep, scarcely less destructive than the first, and equally transitory. The moon takes but seven days and a half in passing from the situation in which she has the greatest, to that in which she has the least influence, and vice versa; and it will probably be found, that that is about the average duration of the violence of the epidemic.

No perfect parallel to these occurrences is to be found in the histories of other epidemics; but the alternate increase and diminution at short intervals which they frequently exhibit, has been sufficient to excite very marked observation. "Baronius, from Gregory of Tours, has well described the first progress of the plague in 590, in the southern cities of France. He says the disease was introduced by a vessel from Spain—the first record I can find of supposed importation by water. But when introduced, it did not seize every house at one time, but left intervals. 'Nec statim hoc incendium luis per domos spargitur totas, sed interrupto certi

temporis spatio, ac velut in segetem flamma accensa, urbem totam morbi incendio conflagravit.' The metaphor here employed will appear striking to those who have seen a field of stubble or the woods on fire on a windy day. The fact also corresponds exactly with what has been observed in London, Marseilles, and other places, that the disease starts up here and there, in remote situations; then subsides for weeks, perhaps, before it spreads and becomes popular. *** In London, to use Hodge's quaint expressions, 'it reigned doubtfully—it kept up a running fight,' alternately inspiring hope and fear. This description is less elegant than that of Baronius, but it expresses the same ideas of the first progress of the plague. Similar in all respects was the commencement of the plague at Marseilles in 1720. At first a few persons died suddenly, then the disease disappeared. Repeated hopes and fears were revived by the alternate appearance and disappearance of the malady for some weeks in May and June. Yet the author who has related these facts has made a book to prove its origin from Levant infection! So absurd are men when they attempt to support preconceived systems*."

On the facts which have been adduced, an expectation may well be formed, that the general exacerbations of other epidemics, as well as of cholera, will usually be found to correspond to the moon's syzigies, and the remissions to her quarters.

It is a fact which has been universally observed, particularly in tropical climates, that the moon has a great influence on the weather, the full and change tending to produce rain and storms, and the quarters being more frequently attended by fine weather. This is so well ascertained, and so thoroughly believed, at least in India, that it is nearly superfluous to adduce arguments or instances in support of it. On every side, then, we perceive the intimate connection which exists between the

* Webster's History of Epidemical Diseases, vol. ii, p. 270.

three series of phenomena which have been noticed—the great lunar periods, disturbed states of the atmosphere, and the attacks of the epidemic.

It will also be proved, that the other principal circumstance which has been supposed to attend the prevalence of cholera, the depression of the barometer, is likewise produced by the new and full moon.

"Mr. Luke Howard has observed a remarkable correspondence between the phases of the moon and certain states of the barometer. This coincidence consists in a depression of the barometrical line on the approach of the new and full moon, and its elevation on that of the quarters. In above thirty out of fifty lunar weeks in 1790, the barometer was found to have changed its general direction once in each week, in such a manner as to be either rising or at its maximum for the week preceding and following about the time of each quarter, and to be either falling or at its minimum for the two weeks about the new and full. It is remarkable, that the point of greatest depression during the year, *viz.* 28.67, was about twelve hours after the new moon on the 8th of November; and that of its greatest and extraordinary elevation to 30.89, on the 7th of February, at the time of the last quarter. The variations from this coincidence seemed to be owing to an evident perturbation of the atmosphere. These observations were confirmed by observations made for ten years in the Royal Society's apartments. Mr. Howard supposes therefore, that the joint attractions of the sun and moon at the new moon, and the attraction of the moon predominating over the sun's weaker attraction at the full, tend to depress the barometer by taking off the gravity of the atmosphere, as they produce a high tide in the waters by taking off from their gravity; and again, that the attraction of the moon being diminished by that of the sun at her quarters, this diminution tends to make a high barometer together with a low tide, by permitting each fluid to press with additional gravity on the earth.

"It is demonstrated a priori on the principles of the Newtonian philosophy, that the air ought to have its tides as well as the ocean, though in a degree as much less perceptible as is its gravity*." If this observation were strictly true, and the tides of the atmosphere were to those of the sea as the specific gravity of air is to that of water, the aerial tides must be extremely small, for the weight of air is very trifling compared to that of water. But it is known that the height of the tides of the sea bears some proportion to the extent of the sea uninterrupted by land, and to its depth. On both these accounts we should expect, that the atmosphere would be more influenced by the moon's attraction than the sea, for it is vastly deeper and more extensive than the sea, and entirely unconfined.

"Sig. Toaldo found that a greater elevation of the barometer takes place at the quarters than at the syzigies; it is less when the moon is in the northern signs than when in the southern. The mean diurnal height which corresponds to the tropic of Cancer is less by a quarter of a line than that which corresponds to the tropic of Capricorn. It is one-sixth of a line less at the moon's perigee than at her apogee, and one-tenth of a line less at the syzigies than at the quarters. And there are vacillations in the mercury when the new or full moon corresponds to the apogean or perigean points. He found also that the perigee, the new and full moon, and the northern lunistice, are favourable to bad weather; whilst the apogee, the quadratures, and the southern lunistice, are more favourable to good weather.

"Pere Cotte, from observations of thirty-five years, found that the barometer had a tendency to descend at every new and full moon, and to ascend at the quarterly periods. He likewise found, that the perigee and northern declination depressed the barometer, whilst the apogee and southern declination had the opposite effect." His observations on

* Encyclopædia Britannica.

the influence of these situations of the moon on the weather agree with those already detailed. "The apogee, the quarters, and the southern lunistice, bring commonly good weather. The other (opposite) points tend to render the gravity of the air less, and thus cause bad weather by assisting the precipitation of vapour. The combination of syzigies with the apses are very powerful; but the new moon with the apses carries always a moral certainty of a great commotion in the air*."

"M. Lamarck considers the following principles as established by his observations.

"1. It is in the elevation of the moon above, and her depression below the equator, that we are to search for those regularly varied effects which she produces on our atmosphere.

"2. That the determinable circumstances which conspire to increase or diminish the moon's influence in her different declinations are—her apogees and perigees, her conjunctions with and oppositions to the sun, and lastly the solar solstices and equinoxes.

"He is convinced that the half of the lunation in which the moon is on the north of the equator is marked by small elevation of the barometer, cloudy and moist weather, and storms. On the contrary, in the other half, when the moon is passing from the equator to the southern tropic and back, an opposite constitution prevails — the barometer is high, the weather clear, cold, and dry, and storms extremely rare.

"The changes produced by the lunar situations seldom take place on the exact days on which these situations happen, but either precede or follow them; and Toaldo has found, that in the six winter months the changes of weather commonly precede the lunar situations, whereas in the six summer months they more commonly follow them†."

* Robertson on the Atmosphere.

† Encyclopædia Britannica.

Dr. Robertson informs us, that similar circumstances to the above have been noticed by M. Lambert, Marriotte, Fouchy, and De La Lande. "M. Cassan has likewise perceived that the barometer rose two-thirds of a line twice every twenty-four hours in St. Domingo; and that this rise always corresponded with the tides of the ocean."

The foregoing observations are all agreeable to the known laws of the tides; a great tide corresponding to a low barometer and bad weather, and a small tide to a high barometer and fine weather.

"1. The tides are highest at the syzigies and lowest at the quarters.

"2. The tides, under similar circumstances, are greatest when the moon is at her smallest distance from the earth, or in her perigee; and, gradually diminishing, are smallest when in her apogee. The same remarks are made regarding the sun's distance; and the greatest tides are observed during the winter months of Europe (when the sun's distance is least).

"3. The tides, in any part of the ocean, increase as the moon, by changing her declination, approaches the zenith of the place. The heights of the tides diminish as they recede from the equator. At the pole there is no daily tide, but there are two monthly tides; and it is low water when the moon is in the equator.

"4. The high tides in the spring are found to precede the lunar periods, and in autumn to follow them.

"Before high tides there is almost always a great fall in the mercury; this takes place oftener at the full than the new moon*."

In reviewing this mass of evidence of the effects of sol-lunar attraction, it is pleasing to observe that there is none of that inconsistency which might be expected from the proverbial mutability and uncertainty of the atmosphere. It con-

* Encyclopædia Britannica.

tains the results of the inquiries of the most eminent observers of meteorology, several of whom have devoted nearly their whole lives to the subject; and the almost entire agreement of these results is the strongest proof of their truth. The information which they contain may be summed up in a few words.

1. The syzigies (new and full moon), the lunar perigees (those situations in her orbit in which she approaches nearest to the earth), and the northern lunistices* (the points of the moon's greatest northern declination, where she is vertical at about 30° north latitude, and reaches her greatest altitude to all places north of that parallel), are attended by high tides, a diminished gravity of the atmosphere, and consequently a low barometer, and bad weather. It is proved that the most remarkable of these situations of the moon are productive of disease; and from analogy we may infer that they all have that tendency.

2. The opposite situations to the above—the quarters, the apogees, and southern lunistice, are attended by the least tides, a high barometer, and fine weather. And it is equally evident that the sol-lunar influence in producing disease is at these periods the least.

3. The solar perigees and apogees, and the alterations in his declination, produce effects similar to those of the moon; but it is to be inferred from theory, that these effects will be as much less as the attraction of the sun for the earth is less than that of the moon.

The passages of the sun and moon over the equator are also observed to have considerable influence. The equinoxes (the sun's passages over the line) have been constantly found to be attended by high tides; they have also been found to be accompanied by storms, by Toaldo, Cotte, and others, which are well known under the name of the "equinoctial

* The observations on this situation must be considered as relative only to countries north of the line.

gales." And Dr. Balfour has remarked, that at these periods the morbific influence is likewise uncommonly great.

In the preceding observations on the influence of the sun and moon on this epidemic, the syzigies and quadratures alone have been taken into account; but it is evident that these, though the principal, are far from being the sole circumstances of importance.

The lunar perigee (or greatest parallax) is also very powerful. In this situation the moon is nearest the earth, and seven and a half semidiameters of the earth, or nearly 30,000 miles nearer than at her greatest distance; a circumstance which makes a very evident increase in her apparent magnitude. It is obvious that her attraction for the earth in this situation must be much increased; and accordingly it is found (as already related), that the lunar perigee has great effect in raising the tides, in depressing the barometer, and in producing storms and rain. Mr. Farquhar has observed at Calcutta, that when it happened at the quarter, the tides were nearly as high as at new or full, and that when it occurred at either of the latter periods, it was attended by a very high tide, and a strong *bore** (current in the river). Dr. Balfour has likewise observed that this situation of the moon was attended by an increase of the morbific influence.

"Although the general theorem, which I have advanced in the preceding pages, describes the prevailing tendencies during the springs and neaps, it is necessary to observe, that those tendencies are liable to frequent and remarkable deviations, from the various stations that the moon may happen to occupy in her own orbit; by which her distance from the earth may be considerably increased or diminished; and consequently her power.

"From observations lately made at the general hospital at Calcutta, by Mr. James Howison, Dr. John Campbell, and Dr. John Fullarton, it appeared that the moon, during the

* Balfour, on Sol-Lunar Influence, p. 260.

period of her greatest horizontal parallaxes, had sufficient power to suspend, in a very conspicuous manner, the common tendency of the neaps to produce a remission of fever. And when the greatest horizontal parallaxes happen to coincide with the power of sol-lunar influence during the springs, we may reasonably infer that the power of exciting and supporting paroxysms must then be raised considerably above their usual force*." On the same grounds it is to be inferred that the lunar apogee (greatest distance, or least horizontal parallax) will have the effect of lessening the tendency to disease; when it coincides with the new or full it may in a great measure destroy their influence; and when it happens at one of the quarters, it will probably increase the tendency to health.

The perigee and apogee of the moon are, therefore, objects of importance to the medical observer. Each of them occurs once in each lunar month, and nearly at the distance of half the lunation from each other; but at no certain periods of the phases, for if at any time they are found to take place at the syzigies, in the course of a few months they will be found to happen at the quarters. It must also be remembered, that the moon approaches nearer to, and recedes farther from, the earth in some revolutions than in others; whence correspondent variations in her influence are to be expected. It is highly probable, that if the combinations of these circumstances with the syzigies and quadratures were compared with a sufficient nnmber of the sudden appearances and cessations of this epidemic, the results would be extremely important and interesting. We cannot doubt that great uniformity prevails in the operations of nature, and that it is our ignorance alone which so frequently makes them appear irregular and accidental.

The perigee and syzigies are the most powerful points; and therefore, when the former coincides with either of the

* Sol-Lunar Influence, p. 399.

latter (that is, when the moon is nearest at new or full), the influence by which disturbances in the ocean, the atmosphere, and the animal frame are produced, must be greatly increased. Signor Toaldo affirms, that this combination at new moon carries *always a moral certainty of a great commotion in the air.*

"According to Toaldo's observations, storms occur almost always at some of the lunar points, combined or separately. The following is a table of their proportions.

Lunar points.	Proportions.
New moon with perigee	33.1
New moon with apogee	7.1
Full moon with perigee	10.1
Full moon with apogee	8.1 * "

Dr. Mead has recorded a most violent storm which took place when the moon was at new and at perigee, attended by extreme depression of the barometer, and followed by uncommonly high tides; and he adds, that many persons were taken ill at the same time. He likewise mentions another, which occurred at the full moon, and the autumnal equinox, on the day of Oliver Cromwell's death†.

* Robertson on the Atmosphere, vol. i, p. 398.

† Imper. Sol. ac Lunæ, 99-108.—This storm commenced about midnight; that is, when the influence of the sun and moon at change must have been at its maximum. It ceased six hours afterwards, when these bodies must have been about the horizon, and consequently their attraction at the place almost annihilated for a time. Webster observes, that "great storms of wind, snow, and rain, usually begin, abate, and cease at certain hours, *viz.* at six, nine, twelve, and three o'clock, especially at six and twelve." It is probable, that attention to these circumstances, particularly in tropical climates, in comparision with the situations of the sun and moon, would elucidate not only their causes, but those of the diurnal exacerbations and remissions of disease; to which they appear to bear some analogy. Volta has remarked, that

On these principles we may expect to find a remarkable increase of disease when the perigee happens at the time of the syzigies; and with this farther deviation from common occurrences, that the effect will be in a great measure confined to one portion of the lunar month, instead of happening as usual at two periods of it: for if the perigee is at new, the apogee will be near the full, and will probably in a great degree counteract the influence of the latter point. On the same theory we should expect to find that the attacks of disease will *precede* the new or full moon, when the perigee happens a little before either of these points; and, on the contrary, when it follows them, that the attacks will happen a short time *after* the new or full; for the same reason that the equinoctial high tides precede the vernal, and follow the autumnal equinoxes: the solar perigee happens in winter, and therefore the highest tides are nearer to it in both instances than the equinoxes. Dr. Darwin asks:—"Do not the cold fits of lunar diseases commence a few hours before the southing of the moon, during the vernal and summer months, and before the northing of the moon during the autumnal and winter months? Do not the palsies and apoplexies which occur about the equinoxes, happen a few days before the vernal equinoctial lunation, and after the autumnal one? Are not the periods of the diurnal diseases more obstinate, that commence many hours before the southing or northing of the moon, than those which commence at other times? Are not those palsies and apoplexies more dangerous which commence many days before the syzigies, than those which happen at other times?"

thunder-storms have a tendency to return at the same time of every day, whatever hour a series of them may have commenced at. There is a very strong tendency to rain and storms in India, in the evenings. Thunder-storms rarely occur at any other time. In unsettled weather it seldom fails to rain at this time, and as generally continues fair all the first half of the day.

The moon was at her perigee between the 16th and 17th of August 1817; that is about three days after the change. If then the epidemic made its first appearance in the middle of August, it must have happened between the perigee and change, when they were near each other; and consequently at a time when the influence must have been great.

The perigee coincided with the change on the 9th November 1817, three days previous to the commencement of one of the most fatal attacks of the epidemic which we have heard of, that of the Most Noble the Commander in Chief's camp. In this instance the disease abated about the full; but this circumstance may have arisen from the *apogee* which necessarily occurred about that time, and which must have counteracted the morbific influence of the full, as much as the perigee increased that of the change.

If, as we are informed, the disease appeared at Chuprah on the 13th September, it must have happened on the day of the perigee, and two days after the change. And it would appear that it was on the decline here likewise, during the ensuing full with apogee. In all the four months of 1817, in which the disease prevailed, the perigee happened near the change; whence it is probable that the morbific influence was particularly great at these periods of those months.

The perigee coincided with the full moon of May 1818; and this is the date of the attack at Nagpour; and, as far as I am informed, of the first considerable appearance of the disease on the Peninsula. It must however be observed, that the approach of the new moon, in this instance, appeared to have a great influence, though attended by the apogee. It is very probable that the effect of the various situations of the sun and moon may occasionally be suspended until a considerable time has elapsed, and the situations themselves are completely altered.

The variation in the moon's declination or meridian altitude is probably of little importance in the torrid zone; for except

at its extremes (the tropics) it never amounts to any considerable sum, in comparison to other parts of the world; as that luminary never removes farther than 30° from the line. Mr. Farquhar states in a letter to Dr. Balfour: "I have not been able to observe that the moon's declination (at Calcutta), notwithstanding what you may have heard from other quarters, has any perceptible effect on the tides." It appears therefore that this circumstance may be neglected in our observations of the lunar influence on the human frame within the tropics, at least until farther evidence of its efficacy shall be adduced. But in countries at a distance from the equator it is probably of great importance. The changes of the moon's declination have been observed in Europe to have great influence both on the tides and the weather; and it is obvious that the smaller degree of influence in producing disease exerted by the sun and moon in Europe, is owing to their smaller meridian altitudes. For it may be proved by mathematics, and is indeed evident to common observation, that the lower these bodies are situated in the heavens, the less must be their power of lessening the gravity of substances on the surface of the earth. The moon at the horizon has no power of elevating the waters or of rarefying the air, where the observer is situated: in the zenith (when she is vertical), cæteris paribus, her attraction is greatest. The sun and moon are each of them constantly vertical to some parts of the torrid zone; beyond 30° of latitude neither of them are ever vertical. The reason of the greater degree of sol-lunar influence in the former than in the latter situations is therefore evident. At the northern lunistice, when the moon arrives at her nearest point to the zenith of Europe, her influence on that part of the world must approximate to that which she exerts within the tropics; and it would appear that this is one of the principal points which the observer in northern climates should attend to. This circumstance, as well as the southern lunistice (maximum of southern declina-

tion) occur, like the greatest and least absolute distances, once in each lunar month; and like them at all periods of the phases. At those times, then, in which the northern lunistice occurs at the syzigies, it will probably tend greatly to increase the morbific power in Europe; but when it occurs at the quarters it will rather tend to destroy it, by equalizing the attraction.

There are likewise other coincidences in the moon's situations, occurring at distant periods from each other, which have been observed to have great influence on the seasons, and therefore may be expected to have correspondent effects on the general health; but the very superficial knowledge of the subject which I possess, does not enable me to pursue it farther. Cotte observes: "The seasons, tides, and years appear to have a period of from eight to nine years, according with the revolution of the lunar apses, another of eighteen or nineteen years, and others of still longer periods;" and this opinion is strongly supported in a valuable article which has recently appeared in the Edinburgh Review. Another period of four or five years has been found to correspond to certain situations of the moon, and successions of seasons. It has been commonly remarked, that the fever at Seringapatam becomes uncommonly severe about every five years.

It may be shown on the Newtonian principles, that in all the situations in which the sun and moon have been found to produce their greatest effects in raising the tides, rarefying and disturbing the atmosphere, and in producing disease, their joint attraction for the earth, or certain parts of it, is greatest; and, on the contrary, when these effects are least evident, that their attraction is least. It is an established principle in the theory of the tides, that a high tide is produced by a diminution of the gravity of the waters where it appears; whence they rise from the surface of the earth, being pressed up by other waters flowing in from parts of the earth where the attraction of the bodies producing the tide is less, and consequently the gravitation to the earth

greater. The same attraction is exerted at the same time on all gravitating bodies, and consequently on the atmosphere; and, therefore, the impetus which raises a tide must also diminish the weight of the atmosphere over it. If air was, like water, incompressible, no other effect would be produced on the atmosphere than on the sea; an accumulation, formed by air flowing in from neighbouring parts, would be formed over the oceanic tide, but without any change of its density. But it is well known that the weight of the atmosphere cannot be diminished without at the same time producing its expansion. This effect, then, appears necessarily to follow from these causes; though it must be in some degree removed by the flowing in of other parts of the atmosphere from places where its gravitation is greater.

There is likewise reason to believe, that the atmosphere must be influenced by the moon's attraction in a greater degree than the ocean, from its greater height, which at once removes it farther from the earth and nearer to the moon. Mead observes: "His accedit, quod ea lex in corporibus, quæ attrahuntur, locum obtinet, ut vires attractionis sint in ratione quadratorum distantiarum suarum reciproca; unde validius multo erit, ob majorem hujus elementi viciniam, in aëra, quam in aquas, solis lunæque imperium. Quid, quod majoris quoque momenti est in æthere virtutis elasticæ consideratio? Cujus hæc est conditio et natura, ut sit pro ratione pressionis, quæ ei incumbit; hinc diminuto, quod incumbit, pondere, immane quantum se in altum explicabit subjectus aer. Verum est profecto hanc ita paulatim minui et decrescere, ut ultra certum a terra terminum sit momenti nullius; ideo tamen vel levis hujusmodi mutatio parit hic effectum maximum, quoniam ab illa fit, ut velocius facultatem trahentem sequatur circumfusa globo volubilis materia.

"Ista quidem omnia et ejusdem generis alia efficiunt, ut ab eadem vi lunari ætheri, quam aquis, longe majores æstus inferantur. Neque patitur hujus instituti ratio, ut operosis calculis, quantum ad hanc rem conferant singula, et quo mo-

mento agant, accuratius exequar. Ad propositum satis est, cum universas esse, tum certis intervallis reverti, dictas aereæ regionis motiones ostendisse *."

The changes of the density of the atmosphere produced by sol-lunar attraction may be small, but in some respects they appear to be of greater importance than the more obvious alterations of the same kind arising from irregular causes. The former must necessarily take place in the whole height of the atmospherical column, and over immense portions of the earth at once, consequently their sum must be great: the latter are frequently very partial, probably occurring chiefly in the upper regions of the atmosphere, to which their most important effects may be in some degree confined.

In the foregoing chapter it has been shown, that the attacks of the epidemic are accompanied or immediately followed by rain, cloudy and moist states of the atmosphere, thunder and lightning, or high winds; and from these circumstances it is inferred that they are likewise accompanied by depression of the barometer. In the present chapter it has been shown, that the periods of new and full moon are in a very remarkable degree attended by the attacks of the epidemic, whilst the quarters are comparatively free from them. It has also been proved that the syzigies are commonly attended by depression of the barometer, rain and storms; whilst the quarters are accompanied by opposite circumstances. It is evident then that these two series of observations on the circumstances attending the epidemic, on the visible states of the

* Imp. Sol. ac Lunæ, p. 12. His theory of sol-lunar influence on the living system is as follows: — The attraction of the sun and moon being increased at the syzigies, the perigees, and the passages over the equator, the weight of the atmosphere under these circumstances is consequently diminished; and it is rendered *mechanically* unfit for respiration, and for supporting the due degree of pressure on the surface of the body, p. 8, 24, 28.

atmosphere, and on the states of the moon, coalesce and yield one result. On these data is founded the following axiom, forming the focus to which all the arguments which have yet been brought forward regarding the remote cause of the disease, have converged: —

The atmosphere during the prevalence of the epidemic is in a rarefied state; and exhibits a great tendency to part with its moisture, forming thick clouds, heavy rain, or haziness; and to become agitated by storms.

It remains to be considered how far these circumstances compose or are connected with the great cause of the disease.

CHAP. IX.

OF THE PRIMARY REMOTE CAUSE OF THE EPIDEMIC.

THE weight of the atmosphere has been calculated, and its pressure on the human body found to amount to many thousand pounds (upwards of eleven tons); from whence it might, a priori, be inferred, that any change which diminished its gravity would produce agreeable and beneficial effects on our frames; but experience has shown that precisely the reverse is the case; for under such circumstances we feel as if oppressed by additional weight. It is well known that rainy, moist, and stormy conditions of the atmosphere, which are attended with a low barometer, and consequently lightness of the air, are extremely disagraeable to the feelings, and unhealthy. No one can be ignorant of the striking effects of this kind of weather in depressing the spirits, and occasioning listlessness, anxiety, and inactivity. This is particularly remarkable before a thunder-storm; and is commonly referred to the heat and stillness of the atmosphere which usually prevail on these occasions, and are termed *closeness* and *sultriness:* but in clear weather we bear much greater degrees of heat without annoyance; and in the serene mornings of India, when there is commonly not the smallest breath of wind, we feel no want of ventilation; on the contrary, these are the periods at which we feel most exhilarated. It is much more probable that the disagreeable sensations alluded to are consequences in the change in the density of the air, which we know by the barometer precedes storms, and is obvious

to the commonest observation in the falling of smoke from the chimney tops. In fact, this circumstance has been very commonly considered as a cause of disease.

"When the ordinary weight of the atmosphere is augmented, the weather is commonly dry and serene; the circulation is promoted, the blood is driven to the internal parts; a more abundant secretion of the juices takes place; the tonic tension of the solid parts is increased; and these circumstances combined render us more lively and active. On the contrary, when the weight of the air is diminished the weather is usually moist and foggy, and the animal frame becomes sensible of oppression, listlessness, and inactivity. These changes in the atmosphere, which are felt more or less by persons of all descriptions, and of which valetudinarians frequently complain, would be more sensibly experienced if they occurred by sudden transitions; for to this circumstance the sensations of uneasiness are chiefly to be attributed; and accordingly great and sudden changes in the barometer are generally accompanied by corresponding alterations in the corporeal frame and animal spirits; but when a change of this kind occurs gradually, and when the same state of the atmosphere continues for some time, its effect is less sensibly perceived *."

It is a common observation, that patients labouring under acute diseases are very subject to exacerbations of them on the occurrence of these states of the atmosphere; a circumstance which I have frequently observed in a very remarkable degree in this country. A writer in the Dictionnaire Raisonné states: "There are many persons who experience the most certain indications of the changes in the atmosphere: headachs, attacks of rheumatism, painful affections in consequence of wounds or luxations, &c., which inform them of the variations of the weather more correctly than the best barometer. I have lately had a patient labouring under a putrid fever

* Rees's Cyclopædia, article Atmosphere.

with affection of the lungs, who experienced a frightful exacerbation of the disease for seven hours during a violent storm. He was extremely anxious, weak, and sunken, and had great difficulty in respiration. After a tremendous clap of thunder the storm ceased, and at the same time the patient felt himself surprisingly relieved, as if a weight with which he had been oppressed was removed, and immediately became convalescent."

Huxham has been particularly impressed with the importance of this morbific cause. He observes: "In medicina utique facienda vides et quibus boreas, mercurium in barometro attollens, officit maxime; vides et quos cum mercurio deprimit humidus auster.

"Annon humida calidaque temperies aeris, æstate prægressa, fibras relaxando plurimum sanguinem atque lympham ad nimium lentorem disposuerat? Idque præcipue cum et istis accesserit atmosphæræ pressura solito plerumque minor? Estne ergo manifesta satis febris hujus et variolarum malignarum unà grassantium, causa? Per talem atmospheræ constitutionem morbi contagiosi haud dubio propagantur maxime."

He believed that the pressure of the atmosphere assisted the circulation of the blood; and in that way has attempted to account for the evident oppression and disease experienced on the air becoming lighter than usual; and the relief produced by the opposite change. "Hinc fit," he says, "quod dum cœlum siccum sit atque serenum, id est quando debita gravitate et elasticitate præditus sit aer, alacres nos, vegetosque percipimus. * * * * * Contra omnino contrarias corporis affectiones infert aer debitæ gravitatis et elasticitatis expers: nam sequitur igitur tardior sanguinis circulatio, diminutæ secretiones, impedita perspiratio, lentorque tandem nimius humorum. Hinc ille corporis et animi languor, quo fere afficimur omnes, dum talis adest atmosphæræ constitutio; quæ porro, persistens usque, ista omnia auget indies, imo vel

ipsa mala, causæ originali succedentia, se mutuo promovent assidue; demumque his ommibus accedunt affectus hysterici et hypochondriaci, febres intermittentes, remittentes, putridæ, lentæ, nervosæ, petechiales; morbi denique omnes a nimio lentore sanguinis et segni ejus circuitu pendentes*."

But this is a mere hypothesis which has no foundation, except in accounting for the facts, and which is directly contradicted by observation. It is evident that not only this theory, but every other which makes the diminution of the pressure and density of the atmosphere the *immediate* cause of these occurrences, must fall to the ground, when it is found that they are *not* produced by excessive lightness of the air under other circumstances. If that theory were true, all the diseases of debility, which Huxham describes, should be produced by a change of residence from a low to a high situation; for it is well known that the atmosphere in the higher regions is much lighter than at the level of the sea; but, on the contrary, high situations are most healthy. In fact, it appears, notwithstanding all the mathematical calculations that have been made of the immense weight of the atmosphere which is borne by the body, that the bare increase or diminution of that weight does not sensibly affect us. Sailors, who live at the lowest part of the earth's surface are generally healthy. Miners, who work far below its surface, are not, at least in temperate climates, unhealthy. In the diving bell the air is extremely condensed, yet it does not appear from thence to be injurious. And in the Encyclopædia Britannica, an instance is related of two gentlemen remaining for some time in a chamber of an engine, where the air was condensed to a very great degree, without feeling any inconvenience. On the other hand extreme lightness of the air of itself appears equally innocent. Haller observes: "Aeris levioris incommoda facile perspicimus. * * * Cum octo tantum lineis mer-

* Huxham de Aere et Morbis Epidemicis.

curius descenderet, passeres extincti. Chloris, cum tamen aves rarum aerem melius ferre credantur, ægrotavit, cum aer dimidio levior esset, et ipsa lacerta languidius vixit. * * * Hinc in aere levi vires franguntur." But he subsequently shows that these effects are not solely to be attributed to the rarity of the air: "Robusti agricolæ enormia pondera per precipites Alpium vias indefessi elevant. Si alii a secessu in montanum aerem, febriculas, deliquia animi, hæmorrhagias exiguas, hæmoptoen, passi sunt, ad contentionem potius adscensus, atque ad intensas vires respirationis retulerim: quiescentes enim viatores iidem nihil ejusmodi patiuntur, neque equis usi*."

The mathematicians who were sent by the king of France to South America, lived several months on the top of the Andes, where the barometer stood at fifteen inches, shewing just half the pressure of the atmosphere on the level of the sea, without the smallest inconvenience from that great change.

Neither can these apparent contradictions be reconciled by supposing that the frame becomes habituated to the changes by their more gradual occurrence. By ascending a hill about nine hundred feet in height, which is accomplished with ease in half an hour, we arrive at a portion of the atmosphere one-thirtieth lighter than on the common surface of the earth: a much greater change than usually takes place in so short a time on the surface; yet so far from being depressed, we are exhilarated by the transition.

In this instance it must be recollected that no change has taken place in the air itself; the transition is produced by our removing from one portion of it to another. But let the barometer sink an inch in half an hour whilst we remain stationary, and we should experience all the injurious effects above detailed in the highest degree, though the density of the air with which we are surrounded, and rapidity of transition, are the same as in the former case. Again, let this

* Elem. Physiol. lib. viii, sect. vii.

change occur very gradually, or let the barometer remain long stationary at this low point, and (agreeable to the observations at p. 238) the injurious effects will be greatly diminished. It is evident, then, that it is *some other change in the air, which accompanies its rarefaction* (a condition which is not inherent in light air), which produces these effects.

The brilliant discoveries of latent heat, and the varying capacities of bodies for heat, have opened a new era in chemistry; and the extension of these principles to ELECTRICITY, which has taken place of late years, may produce not less important results. It has been distinctly proved that the electric fluid, as well as caloric, exists in a latent state; and that the changes of bodies from the solid to the fluid, and from the fluid to the aeriform states, and *vice versa*, produce correspondent changes in the quantity of free electricity which they contain. It has also been ascertained, that *the rarefaction and condensation of air* produce similar changes, on the same principle: and these effects are not to be considered as of partial and accidental occurrence, from the occasional presence of electricity; for it is known that that fluid is universally diffused throughout nature, every body with which we are acquainted containing it, and in particular it is known to form one of the constituent principles of the atmosphere, where its agency is in the highest degree important.

"Bodies lose their capacity to contain electricity in proportion as their volume is diminished*."

"Air, on being expanded, has its capacity for electricity increased†."

"Air in expanding, abstracts electricity from surrounding bodies‡."

"Air, when condensed in an insulated ball, gives out electricity in the first operation, and afterwards caloric: air, when condensed in an air-gun, as soon as discharged in a

* Wilkinson's Elements of Galvanism, vol. i, p. 223.

† Ibid. vol. ii, p. 223.

‡ Ibid. vol. ii, p. 233.

dark room, disengages light by the sudden abstraction of electricity, so as to render it luminous*."

"A glass jar of a hundred and sixty square inches of coated surface was found, when charged in the open air, capable of fusing one inch and a half of lead wire one hundredth of an inch thick, When it was placed under the condensing apparatus it became capable of fusing a greater quantity in proportion to the aerial pressure. When a jar is placed under an exhausted receiver, the charge is diminished in proportion to the exhaustion†."

"When the capacity for electricity of any body is increased, its conducting powers are also increased‡." "Air, on being rarefied has its conducting powers increased§."

"M. Canton has observed that the rarefaction and condensation of air occasioned changes in its electrical state‖."

It is evident, therefore, that any diminution in the density of the atmosphere must increase its capacity for electricity, and consequently diminish the quantity of that fluid which it possesses in a free state: and if it has been proved that a rarefaction of the air accompanies the prevalence of cholera, it follows that the disease is accompanied by a diminution of the free electric fluid in the atmosphere¶. It is this de-

* Wilkinson's Elements of Galvanism, vol. ii, p. 233.

† Ibid. p. 235. ‡ Ibid. p. 216, 234.

§ Encyclopedia Britannica, article *Electricity*. ‖ Ibid.

¶ As it is possible that this work may be interesting to persons in India not in the profession, to whom this illustration may not be intelligible, I will endeavour to place it in a more familiar point of view. Take a sponge half filled with water, and let the sponge represent the atmosphere, and the water it contains, the electric fluid in the atmosphere. Squeeze the sponge, and its capacity for water will be diminished; the water will appear abundant though its actual quantity is not increased. In the same manner condensation of the air increases its electricity. Again, take off the pressure from the sponge, and its capacity for water will be increased; the water will be absorbed and the sponge appear dry. Thus, likewise, rarefaction of the atmosphere *diminishes* its electricity.

ficiency, produced in this and in other ways, which I consider the great and immediate cause of the epidemic.

It is possible, however, that rarefaction of the atmosphere may not have any important share in the *production* of this supposed cause; but the more important fact of the *existence* of a deficiency of the electricity of the air during the prevalence of the disease, will be rendered evident, independent of this theory, when it is shown—

1. That the depression of the barometer is *attended* by a diminution of the quantity of free electric fluid in the atmosphere.

2. That the meteorological occurrences which have been observed to accompany the epidemic are either produced by or attended with, a diminution of the quantity of free electric fluid in the atmosphere.

3. That some very remarkable and uncommon phenomena, of an electrical nature, and connected with atmospherical electricity, have attended the disease.

The preceding observations sufficiently show that the effects alleged attend changes in the density of small quantities of air, artificially induced; it has likewise been found that they attend the natural expansions and condensations which take place in the atmosphere. It is well known that an elevation and depression of the barometer takes place twice every twenty-four hours, corresponding to the same hours of each day, the causes of which have not yet been clearly ascertained: it has also been found, that a similar increase and diminution of the electricity of the atmosphere takes place at certain periods, twice in every twenty-four hours. These circumstances are sufficient to lead to a presumption that the phenomena are connected with each other; and this opinion becomes strengthened in the highest degree when it is found, that the two maxima and minima of the density and electricity of the atmosphere correspond nearly to the same hours of the day and night.

Mr. Horsburgh, in a continued series of observations in

the Indian seas, ascertained that the barometer fell from noon to 4 P. M., when it was lowest; it rose from that time till 10 or 11 P. M., when it was highest; from midnight to 4 A. M. it fell, at the latter period again reaching its lowest point; from thence it rose again till 10 or 11 A. M., when it was again at its highest*.

M. de Humboldt found, in the inter-tropical parts of South America, that the barometer was highest at 9 in the morning, and that it sunk until 4 in the afternoon, when it was lowest. From this period it rose till 11 at night; but did not reach an equal height to 9 in the morning. From 11 at night it continued sinking till 4 in the morning; but did not become so low as at 4 in the evening.

Dr. Balfour found that the barometer at Calcutta fell from 10 at night till 6 in the morning; rose from thence till 10 in the morning; sunk again till 6 in the evening; and rose from 6 till 10 at night†.

Mr. Read found in England, that "when the weather is tolerably settled, or such that no other cause is active than that proceeding from the change of day for night, or night for day, the signs of electricity in the atmosphere gradually decrease from 12 at night till 6 in the morning; from this hour till nine they gradually increase; when they become exceedingly weak, and continue so till 4 in the afternoon. The increase at this time commences, and is very decisive till about two hours after sunset; when it becomes stationary and remains in that state, or decreasing so as scarcely to be sensible, till the morning‡."

It appears from the observations of M. Saussure at Geneva, that the electricity of the air is pretty strong at 9 in the morning; from thence it gradually diminishes till 6 in the evening, when it reaches its first minimum; after which it increases till 8, and arrives at its second maximum; from

* Indian Directory.

† Asiatic Researches, vol. iv, p. 196.

‡ Encyclopedia Britannica, art. *Electricity*.

thence it again gradually declines till 6 next morning; the time of its second minimum*.

M. Schubler found in Europe, that "the atmospherical electricity in *calm and serene weather is constantly positive*, subject however to two daily fluctuations. It is at its minimum a little before sunrise; it then gradually accumulates and reaches its first maximum a few hours afterwards (8 o'clock in May); at this period it begins to diminish till it has successively descended to its second minimum. The second maximum of atmospherical electricity exists in the evening, about two hours after sunset; it then diminishes, at first rapidly, and next in slower progression, during the whole of the night, to present again on the following day the same oscillations. These regular fluctuations may be observed throughout the year, more easily in fine than in cloudy weather, and of greater duration in summer than in winter. They are not influenced by temperature†."

The comparison of these two series of phenomena will be facilitated by the following abstract.

BAROMETER.

	Falling.	Rising.	Falling.	Rising.
Horsburgh,	10-11 A.M. to 4 P.M.	to 10-11 P.M.	to 4 A.M.	to 10-11 A.M.
Humboldt,	9 A.M. to 4 P.M.	to 11 P.M.	to 4 A.M.	to 9 A.M.
Balfour,	10 A.M. to 6 P.M.	to 10 P.M.	to 6 A.M.	to 10 A.M.

ELECTRICITY.

	Falling.	Rising.	Falling.	Rising.
Read,	9 A.M. to 4 P.M.	to 8-12 P.M.	to 6 A.M.	to 9 A.M.
Saussure,	9 A.M. to 4 P.M.	to 8 P.M.	to 6 A.M.	to 9 A.M.
Schubler,	8 A.M.	8 P.M.	to 5½ A.M.	to 8 A.M.

The mean results are as follows:

	1st Maximum.	1st Minimum	2d Maximum.	2d Minimum.
Density,	10 A.M.	4-5 P.M.	10-11 P.M.	4-5 A.M.
Electricity,	8-9 A.M.	4 P.M.	9 P.M.	6 A.M.

* Encyclopædia Britannica, art. *Electricity*.

† Journal of Science and the Arts, No. 4.

M. Saussure has presented very minute details of the meteorological phenomena occurring during three days at Geneva*. The following table contains the observations on the barometer and electrometer for the first day, which was perfectly serene.

	Barometer.	Electrometer.
9 A. M.	26.6. 7	2—
11	26.6. 5	1—6
2 P. M.	26.6. 1	1—1
5	26.6. 1	1—1
6	26.6.	1—0
7	26.6. 2	1—8
8	26.6. 3	2—
9	26.6. 3	1—8
10	26.6. 1	1—2
11	26.6.	1—5
12	26.5.15	1—2

In eight of the ten observations, we see the barometer and electrometer were both rising, falling, or stationary together. In only one instance is the electricity increasing whilst the density of the air is diminishing. On the remaining two days the weather was more disturbed, and consequently this coincidence less marked, though still very evident.

Such facts are too remarkable to have escaped notice. They are alluded to by Mr. Wilkinson, who informs us that "Volta and Read have observed a coincidence between the daily changes of the barometer and the state of atmospherical electricity. As the barometer is higher in the morning and evening than in the middle of the day, so likewise has the atmosphere at these times been observed to be more electrical†."

In the eleventh number of Thompson's Annals of Philosophy, is an account of a most interesting discovery by

* Encyclopedia Britannica, art. *Electricity*.

† Electricity of Galvanism, ii, 279.

Dr. Prout, of a regular diurnal variation in the quantity of oxygen gas consumed in respiration; which appears to correspond in a considerable degree with the electrical changes in the atmosphere according to the observations of the accurate Read. Dr. P. has observed, that "the quantity of oxygen gas consumed, and consequently of carbonic acid gas formed, in respiration, is not uniformly the same during the twenty-four hours, but is always greater at one and the same part of the day than at any other time; that is to say, its maximum occurs between 10 A. M. and 2 P. M., or generally between 11 and 1; and its minimum commences about 8^h 30′ P. M. and continues nearly uniform till about 3^h 30′ A. M. * * * * The quantity of carbonic acid gas which has remained stationary at 3.30 per cent., its minimum, about 3^h 30′ A. M., suddenly begins to increase, at first slowly, afterwards more rapidly, till about noon; when it is usually as high as 4.10 per cent., or its maximum. From this point it almost immediately begins to sink, at first rather quickly, afterwards more slowly, till about 8^h 30′ P. M." He conceives that these variations are regulated by the presence and absence of the sun: and observes, "are not all the most powerful agents in nature, as heat, light, *electricity*, magnetism, &c., which appear to influence so immediately and energetically animal life, directed and governed, with respect to their periodical changes, by the earth's motion on its axis and in its orbit; which act only by placing it in different positions with respect to the sun?"

Read found the signs of electricity gradually decrease from 12 at night to 6 in the morning. Prout finds the quantity of oxygen gas consumed begin to increase about 3 in the morning; that is, during the decrease of the electricity. Read found the electricity (after an increase) becoming exceedingly weak at 9 in the morning, and continue so until 4 in the afternoon. About the middle of this period, then—when the electricity is "exceedingly weak,"—the maximum of oxygen gas consumed, occurs. The electricity *increases* from 4 till about two hours after sunset. The quantity of oxygen gas

consumed *diminishes* from about noon till about half past eight. At this time the electricity (at its maximum) "becomes stationary, and remains in that state, or decreasing so as scarcely to be sensible, till the morning." At this time, too, the oxygen gas (about its minimum) becomes stationary, and "continues nearly uniform until 3^h 30′ A. M."—It must however be observed, that no diminution of the consumption of oxygen gas, corresponding to the *morning* increase of electricity, has been noticed*.

Dr. P. likewise remarks: "I think I have found the quantity of carbonic acid gas formed *increases* during the *sinking of the barometer;*" which perfectly agrees with the foregoing theory. He mentions a particular day (22d of August, 1813), on which a remarkable increase of the quantity of oxygen gas expended took place; and the state of the atmosphere on that day appears to have been very similar to that which attends cholera. "The maximum at noon was 4.90 per cent.; and the minimum at 8^h 20′ as high as 4.15 per cent. * * * The barometer varied from 29.80 to 29.70, during the day; which was rather below the mean of the preceding and subsequent periods. The mean of thermometrical range was 61. The hygrometer made considerable advances during the day towards *damp*. The air was calm; showers occasionally fell, composed of very large drops, as occurs in thunder weather." (These expressions are verbatim the same as those of the gentleman who described to me the state of the weather during the prevalence of the epidemic in General Smith's force.—See page 174)†. "In the evening there was a good deal of rain. I HAVE REASON TO BE-

* On reference to the original paper, I find that this morning depression of the oxygen gas consumed, has actually been observed by Dr. Prout, but was "very trifling, and sometimes not at all perceptible." He states that it occurs *between six and eight* A. M. Mr. Brande also finds a diminution of the gas consumed *in the morning*.—Note to the second edition.

† Are not these what M. de Humboldt terms "electric showers?"

LIEVE, THEREFORE, THAT THE ATMOSPHERE WAS IN A HIGHLY ELECTRICAL STATE."

Does the deficiency of electric fluid in the atmosphere render necessary to the system the *decomposition* of a larger quantity of oxygen gas in the lungs, and vice versa? And if the system is unequal to this additional task, must not disease be the consequence?

It is very remarkable that Dr. P. has found "whenever the quantity of oxygen gas consumed has been by any cause increased or raised above the natural standard of the period, it is consequently as much decreased or depressed below that standard, and vice versa." This circumstance suggests an analogy to the tides; and as it is known that the sun and moon have a tendency to produce tides in the air, it is not improbable that some connection exists between them and these most remarkable affections of the function of respiration. Is there a greater quantity, or a greater fluctuation in the quantity, of oxygen gas consumed at new and full moon (when the solar and lunar tides coincide) than at the quarters (when they counteract each other)? Is a less quantity of oxygen gas consumed when the sun and moon are both at the horizon at new or full, than when they are in the opposite situations? —To return from this digression.

Other observations have been made, which farther prove a correspondence between the gravity and electricity of the atmosphere:—

"The barometer is high in serene weather, and particularly in frosty weather."

"Electricity is abundant in the atmosphere in serene weather and during frost*."

"The barometer is generally lower in summer and in warm weather, than in winter or in cold weather; and stands highest in both seasons during fair weather†."

"The proportion of electricity in the atmosphere during

* Encyclopedia Britannica, articles Barometer and Electricity.

† Robertson on the Atmosphere, vol. i, p. 94.

winter appears to be much greater than what it contains during summer*."

The science of meteorology is still in its infancy, and the causes of its phenomena are far from being perfectly explained; but much light has been thrown on the subject since the important agency of aerial electricity has been discovered and appreciated. It may be said, without hesitation, that no change whatever takes place in the atmosphere without being either an effect or a cause of a correspondent change in its electrical state.

It appears to be clearly ascertained, that water in the state of vapour, or in that form in which it is diffused through the atmosphere, has a greater capacity for the electric fluid, as well as for caloric, than when in the liquid state; and that an additional quantity of the former principle, as much as of the latter, is necessary to enable water to assume and retain the æriform state.

"According to Mr. Read, vapour has a greater capacity for electricity, or absorbs and requires more of that fluid, than water, its denser state; and therefore rarefaction must diminish and condensation increase the sensible electric charge of vapour.

"The experiments of Volta and Saussure have shown that evaporation produces negative electricity†.

* Ibid. vol. i, p. 35. The diurnal and septenary variations of the barometer are much more remarkable and constant in tropical than in temperate climates; thunder storms are more violent; and indeed all the operations of nature appear to be upon a larger scale, and more regular, in these than in other countries. It does not appear that a regular series of experiments and observations on the electricity of the atmosphere has ever been made within the tropics, though it is probable from these circumstances that it would be attended with new and important results: but the erratic life of the soldier, and the want of instruments, throw almost insuperable obstacles in the way of many who might be induced to make such attempts.

† The term *positive* electricity, expresses that state of a body in which it possesses more than its natural quantity of electric fluid, or

" Drying a woollen cloth before the fire makes it negatively electric*."

" Electricity seems to be *the immediate bond of connection between the atmosphere and water which is suspended in it.* It is by its various operations that the phenomena of rain, snow, and lightning, and various other kinds of meteors are occasioned†."

" Electric fire, as well as common fire, gives repulsion to particles of water, therefore electrical fire, as well as common fire, assists in raising vapours.

" The abstraction of electrical fire from vapours occasions it to resolve into rain‡."

" Dr. Kirwan imagines that the immediate cause of rain is in consequence of the subtraction of the electric fluid, which keeps the particles of vapour at a distance from each other. This most frequently happens from the repulsion or attraction of other clouds; thence ensues an increased volume of these particles; which by collecting form drops, whose weight being superior to the resistance of the air, they necessarily descend and form rain§."

To this theory of the formation of rain, may be opposed that of Dr. Hutton, who supposed that the condensation was produced by the abstraction, not of electric fluid but of caloric. That cause appears equal to the effect; but to prove the truth of the theory it is necessary to show that a diminution of temperature always precedes rain. On the contrary, it very frequently happens that rain is preceded by an increase of temperature. The greatest tendency to rain in India,

more than surrounding bodies, and, consequently, is giving it out to surrounding bodies. *Negatively* electric bodies possess less than the natural quantity, or than other bodies, and therefore attract it from neighbouring bodies.

* Encyclopedia Britannica, articles Electricity and Thunder.

† Ibid. article Atmosphere.

‡ Franklin's Letters on Electricity, *passim*.

§ Robertson on the Atmosphere, vol. i, p. 214.

takes place in the afternoon and evening, which is the hottest part of the day; and it seldom rains early in the morning, which is by far the coldest.

" It is remarkable that the part of the atmosphere at which clouds form, has not arrived at the point of extreme moisture, or near that point, even a moment before their formation. They are not formed, then, because a greater quantity of vapour had got into the atmosphere than could remain there without passing its maximum. It is still more remarkable, that, when clouds are formed, the temperature of the spot in which they are formed is not always lowered, though this may sometimes be the case. On the contrary, the heat of the clouds themselves is sometimes greater than that of the surrounding air. Neither, then, is the formation of clouds owing to the capacity of air for combining with moisture being lessened by cold; so far from that, we often see clouds which had remained in the atmosphere during the heat of the day, disappear in the night after the heat of the air was diminished. * * * The formation of clouds and rain is neither owing to the saturation of the atmosphere, nor the diminution of heat, nor the mixture of airs of different temperatures *."

The other opinion of the cause of these phenomena is not liable to these objections; and it appears to be attended by all the simplicity and complete evidence which usually accompanies truth. A portion of air brought into the negative state of electricity by rarefaction or other causes, and with its conducting power also by the same means increased, comes into contact with other portions of air, loaded with moisture, but possessing a sufficient quantity of electric fluid to enable it to retain the transparent state; consequently the electricity is abstracted from the latter; they are converted into clouds (or portions of vesicular vapour, which is the first process in the formation of rain); and from a farther loss of electricity

* Thomson's Chemistry, vol. iii, p. 321.

rain is produced. Accordingly it is almost invariably found that clouds are negatively electrified; and particularly when they are about to resolve into rain.

It is generally observed, that the electricity of the atmosphere is positive and strong in serene and dry weather; and that it becomes weak or negative, or rapidly changing from positive to negative, and *vice versa*, in the opposite states of the atmosphere. It is a striking fact, that negative electricity is *never* found in the air in fine weather, except, perhaps, from local causes originating on the earth*.

M. Cavallo concludes, that "the presence of clouds generally lessens the positive electricity of the electrical kite; when it rains its electricity is generally negative, and very seldom positive."

"Signor Beccaria found that the electricity of the air is usually positive, and has a manifest relation to the state of the vapour it contains. The electrical indications of the apparatus are frequently affected by the passage of clouds over it, and by the transition of a current of air from any situation where clouds are forming or vapours falling. With the exception of circumstances of this kind, negative electricity is rarely observed in the atmosphere†." Observations almost precisely similar are made by Saussure. He particularly remarks, that in serene weather the electricity is always positive. The experiments of Mr. Read have led him to the same conclusions.

* Read has found that the *miasmata from vegetable putrefaction* occasion negative electricity in the air. Is not, then, the air of marshes (where the decomposition of much vegetable matter is continually going on, particularly in hot weather) negatively electric? And is not this an approach to the solution of that celebrated medical problem, the cause of the unhealthiness of marshes? The thick and luxuriant jungles of India are equally productive of fever with marshes; and it is generally ascribed to the great quantities of moist putrefying vegetable matter they contain, occasioning a vegetable mould of the richest nature.

† Encyclopedia Britannica.

Mr. Crosse (who is mentioned by Mr. Singer as a most active and intelligent electrician, who had made very numerous observations with a remarkably extensive atmospherical conductor) infers: "*That in the usual state of the atmosphere, its electricity is invariably positive; whenever the negative electricity is observed in the apparatus it is certain that there is either rain, snow, hail, or a mist in its immediate neighbourhood, or that a thunder cloud is near**."

It is evident, therefore, that the occurrence of clouds and rain indicates a deficiency of the electric fluid in portions of the atmosphere; and as these phenomena have been shown to attend the prevalence of the epidemic, it is equally evident from thence that this state accompanies the disease†.

The thick, misty, or "whitish" state of the atmosphere, on the same principles lead to the same conclusion. From the

* Singer's Elements of Electricity.

† I have of late had reason to believe that the connection between the disease and the rainy *seasons* is less uniform than I previously supposed. Some instances have occurred of its appearances with severity in December, January, and February, 1819-20. I have met with only one more account of the state of the weather during these attacks, which is as follows:—

"Extract of a Letter dated December 31, 1819, from the Bengal Hurkaru of the 25th ultimo.

"The day we marched from Lohargong, where they had but very few cases of *cholera*, the disorder broke out in our camp, and most of those who were attacked that day, died in a very few hours. The disorder continued with us till the day we arrived at Jubbulpore, when it ceased entirely. It was not raging in any of the towns or villages we passed through, nor were they subsequently infected with it. During this time the weather was cloudy, now and then a slight fall of rain, but the night previous to our marching into Jubbulpore, it rained very heavily, and continued raining the following day and night."

Here we again observe the remarkable fact of the heavy rain immediately preceding or attending the cessation of the epidemic; and the occurrence of a series of cloudy and rainy weather at a time when the atmosphere in the part of the country where the disease appeared (Bengal) is usually in a state of perfect serenity.

deficiency of the electric fluid, the water contained in the air is unable to retain the perfectly aeriform state, in which it is transparent.

On this theory of the cause of cholera we are likewise furnished with an explanation of the remarkable incongruity of rain appearing in some instances the cause, and in others the cure of the disease. *The cause of the rain is also the cause of the disease;* and the condensation itself, by restoring the electric fluid to the atmosphere, removes the disease. Accordingly, the epidemic frequently precedes the rain, and ceases after heavy rain, and with the *tendency* to rain. Common observation points out occurrences analogous to these during a thunder storm: previous to the rain we feel oppressed and anxious, but on its falling freely, we are instantly relieved. After heavy rain the atmosphere frequently becomes unusually clear; indicating the presence of an unusual quantity of electricity.

It is a common error that the atmosphere is highly charged with electric fluid during thunder storms; we have the strongest evidence that at these periods it contains much less than its natural quantity.

Dr. Franklin infers from his long and able researches, "*That the clouds in a thunder gust are most commonly in a negative state of electricity,* but sometimes positive. The latter, I believe, is rare. *For the most part it is the earth which strikes into the clouds, and not the clouds into the earth.* Those who are versed in electrical experiments will easily conceive that the appearances will be nearly the same in both cases." He likewise mentions, that "in many observations made by Mr. Kinnersly, the clouds were constantly in the negative state, with but one exception*."

Mr. Morgan maintains, that the deficiency of electric fluid which causes the explosion always exists in some part of the atmosphere, and never in the earth†.

* Letters on Electricity. † Encyclopedia Britannica.

Hence it is sufficiently evident, that on the occurrence of thunder-storms, large portions of the atmosphere possess less than their natural share of electric fluid; and consequently strongly attract it from neighbouring portions, or from the earth; whence the flash, sound, and rapid condensation, producing heavy rain, necessarily follow. In fact, it appears, that the principal difference between a thunder-storm and common rain is the more rapid and copious passage of electricity, in consequence of a greater deficiency in the negative portions of air, whence the fluid in its course becomes evident to our senses. Accordingly, the rain which attends thunder is the heaviest. Agreeably to these views we find, that many of the most destructive attacks of the epidemic have been attended by violent thunder-storms.

On the foregoing principles it follows, that positive electricity should increase evaporation; and this has been observed to be the case by Franklin and others. It follows, likewise, that a diminution of the electricity of the atmosphere should retard that process; and, on the supposition that such is the cause of the epidemic, that the evaporation of fluids should be unusually slow during its prevalence. In support of this position I have but one fact to offer. During the prevalence of the disease at Bellary, a very thin piece of linen, resembling muslin, about eighteen inches square, was wetted and wrapt round a wine-bottle for the purpose of cooling its contents, at noon. At 9 P. M. it was still so wet that a very considerable quantity of water was wrung out of it. Heavy rain had previously occurred, but none had fallen for several days. According to the common course of evaporation in India, the cloth would have been completely dry in three or four hours; and in the driest weather, in a much shorter time. I was much struck by this occurrence at the time; and mentioned it in a report to the Medical Board, though I had not then any idea of connecting it with theory.

Does the salubrity of air in general bear any proportion to its power of absorbing moisture independent of temperature? It is observed, that evaporation is more copious in spring than in autumn, in England, though the latter is much hotter than the former; and it is well known that spring is much more healthy than autumn. The land-winds on the Coromandel coast are in a high degree evaporating; and, as it has been already observed, very conducive to health. They have also been observed to be in a very remarkable degree favourable to electrical experiments; but it is doubtful whether that property is owing to their possessing an unusual quantity of electric fluid, or to their less conducting power.

The harmattan in Guinea is not more remarkable for its drying than its salubrious quality; and it does not appear, from the accounts which are given of it, that the former arises from its heat. Is not this extraordinary wind highly charged with positive electricity?

It has been very long and generally observed, that *earthquakes* either accompany or precede severe epidemical diseases. Mr. Webster (who has paid the most minute and laborious attention to all the histories of epidemics, and all the remarkable phenomena of nature, of which any records are to be found) is extremely clear and explicit on this head; and his evidence is such as to place the truth of, at least, this part of his interesting speculations beyond a doubt. He thus concludes:—

"The phenomenon most generally and closely connected with pestilence is an earthquake. From all the facts that I can find in history, I question whether an instance of a considerable plague in any country can be mentioned, which has not been immediately preceded or accompanied with convulsions of the earth. If any exceptions have occurred, they have escaped my researches. It does not happen that *every place* where pestilence prevails is shaken; but during the progress of the disease which I denominate *pestilence*, and

which run, in certain periods, over large portions of the globe, some parts of the earth, and especially those which abound most with subterranean fire, are violently agitated.

"By adverting to the foregoing history, the reader will find that all those years in which considerable earthquakes have occurred in America have been remarkably sickly. These years are 1638, 1647, 1658, 1662 and 1663, 1668, 1727, 1755, 1783. See the history and the Bills of Mortality. Even the slighter shocks have been attended with considerable sickness, or have introduced a series of epidemics, being contemporary with the measles, influenza, or sore throat, as in 1669, 1720, 1737, 1757, 1761, 1769, 1771, 1791, 1797.

"To enumerate the instances in Europe and Asia would be a useless repetition of the events related in the preceding history, to which the reader is referred*."

The epidemic cholera in India likewise affords the strongest confirmation of this remarkable fact. Earthquakes are, in general, by no means common in India, but since the appearance of the epidemic they have been extremely so; and in some instances their effects have been very ruinous.

Several shocks were experienced at Ganjam and Berhampore, in October, 1817. Five shocks were felt in the course of a few minutes at Benares on the 16th of October, 1817, and either the same, or others about the same time, at Cawnpoor, and in camp of the centre division of the Bengal army. Shocks were felt almost hourly at Bencoolen, on the 17th and 18th of March, 1818. On the 16th of June, 1819, a very general and severe shock was experienced. It was felt at Calcutta and in many parts of Bengal, and in Nepaul; at Madras, and at places near the southern point of the Peninsula; at Bombay and in Guzerat; and particularly at Porebunder and Booj. At the last place it was extremel destructive; and numerous shocks were felt in the neighbournood for a month

* History of Epidemical Diseases, vol. ii, p. 15.

afterwards; it was computed that not less than fifty occurred during that time. A pretty severe one was felt at Kaira in Guzerat, on the 23d of July. In that part of the country many shocks were again felt on the 22d of September and the two following days. At Chittagong several shocks occurred on the 11th and 12th of September; at Wallajabad in the Carnatic, on the 2d of October; and at Brutenzorg, near Batavia, on the same day; at Tirhoot on the 3d of August. Four shocks were again felt at Chittagong between the 4th and 20th of October. A Calcutta journalist writes:—"The reports of the late earthquake that extended itself over India had scarcely ceased reaching us from the remoter stations of the interior, before we have to record the shock of another, which was distinctly felt throughout Calcutta on the 11th instant (November). This shock and several others about the same time, were also felt at various other places. I have no doubt that these are far from the whole of the notices of these occurrences which may be met with in the public prints, as I have not engaged in any express search for them.

It may be alleged, that the coincidence of the occurrence of these phenomena, with the uncommonly rainy and stormy seasons, and prevalence of cholera, is merely the effect of *accident*;—the common refuge of the sceptic, and in whose favour he is infinitely credulous. But if it shall be proved that earthquakes are ordinarily, if not constantly, attended by similar states of the atmosphere, it must surely remove any remaining doubts of the intimate connection of the whole three sets of appearances with each other; and enable us (which is the present object) to apply whatever knowledge we possess of the cause of earthquakes to the elucidation of that of the epidemic cholera.

One of the most general observations regarding earthquakes is, that they occur in a still, sultry, and oppressive state of the atmosphere; and this, likewise, has been commonly remarked in India. It is well known that this state is

the common precursor of thunder-storms; and thence a conjecture may arise, that these disturbances have a common origin. The state of the atmosphere previous to the hurricanes in the West Indies, as described by Dr. Mosely, is precisely similar to that which in innumerable instances has been found to precede earthquakes. "The ruin and desolation accompanying an hurricane cannot be described. Like fire, its resistless force consumes every thing in its track, in the most terrible and rapid manner. It is generally preceded by an awful stillness in the elements, and a closeness and *mistiness* in the atmosphere, which makes the sun appear red, and the stars larger. But, a dreadful reverse succeeding, the sky is suddenly overcast and wild. The sea rises at once from a profound calm into mountains. The wind rages and roars like the noise of cannon. The rain descends in deluges. A dismal obscurity envelops the earth with darkness. The superior regions appear rent with lightning and thunder. *The earth often does, and always seems to tremble* * * *. A violent hurricane is generally followed by famine; and when accompanied with an earthquake, by mortal diseases.

"Such were the hurricanes which left melancholy traces in many of the West India islands, in the month of October, 1780: and particularly at Jamaica, where, on the 3d day of that month, the west end of the island was laid waste * * * *. The sea overflowed the land about half a mile beyond its usual bounds, and carried several large ships with it; two of which, when the water subsided, were left nearly a quarter of a mile on dry land. This hurricane commenced from the south-east about noon, and continued until eight in the evening. The sea rose between four and eight o'clock, and subsided at ten with an earthquake *."

On many other occasions heavy clouds, rain, and storms have been found to coincide with earthquakes. Sir Wil-

* Treatise on Tropical Diseases, p. 12.

liam Hamilton, who visited Italy shortly after many parts of it had been desolated by earthquakes, in 1783, and who made them his peculiar study, observes, that the years 1782 and 1783 were very rainy. "The part of Calabria which suffered most from the earthquake was drenched with long-continued and heavy rain, with frequent and furious squalls of wind. These rains prevailed particularly on the western side, where many fissures had appeared." It is likewise said that tempests and rain conspired with earthquakes for the destruction of Messina*. In Swinburne's "Travels in the two Sicilies," we find the following account of one of these earthquakes:— "Before and during the concussion, the clouds gathered, and then hung immoveable and heavy over the earth. At Palmi the atmosphere wore so fiery an aspect, that many people thought part of the town was burning. It was afterwards remarked, that an unusual heat had affected the skin of many persons just before the shock. The rivers assumed a muddy and ash-coloured tinge, and a sulphureous smell was almost general. A frigate, passing between Calabria and Lipari, felt so severe a shock, that the steersman was thrown from the helm, and the cannons raised up on their carriages, while all around the sea exhaled a strong smell of brimstone."

M. de Humboldt mentions an earthquake, by which the city of Cumana was entirely destroyed, on the 21st of October, 1766. "The shocks were hourly repeated for fourteen months.**** What was felt at Quito immediately after the great catastrophe of the 4th of February, 1797, took place on these coasts? While the ground was in a state of continual oscillation, *the atmosphere seemed to dissolve itself into water.* The rivers were swollen by these sudden torrents of rain†." The same author makes the following observations regarding another earthquake at Cumana, and its accompany-

* Encycl. Brit. art. Earthquake.

† Personal Narrative of Travels in South America, vol. ii, p. 216.

ing phenomena. "The days which preceded and followed that of the eclipse of the sun, presented some very extraordinary appearances. It was what in these countries is called the season of winter, that is, of clouds and slight electric showers. From the 18th of October to the 3d of November, a reddish vapour rose above the horizon, and covered in a few minutes, as with a veil, the whole azure vault of heaven. From the 28th of October to the 3d of November, the reddish mist became denser. The heat of the night was oppressive, though the thermometer was no higher than 26°. The breeze which generally cools the air about eight or nine at night did not spring up. The atmosphere appeared on fire, and the burnt and dusty ground was cleft in all directions. On the 4th of November, about two in the afternoon, thick clouds of extraordinary blackness enveloped the lofty mountains of the Brigantine and Tataragual. They extended by degrees to the zenith. About four we had sharp and broken thunder over our heads, though at an immense height. At twelve minutes past four, *the moment of the strongest electric explosion,* there were two shocks of an earthquake. They were preceded by a violent gust of wind, and followed by an electric shower of large drops of rain. A dead calm succeeded, which continued all night. The shock of the earthquake, the clap of thunder which accompanied it, and the red vapour seen for so many days, were all regarded as the effect of the eclipse."

In the "Voyage in search of La Perouse," we find further evidence of the connection of these convulsions of the earth with those of the atmosphere. "We were informed that earthquakes were frequent at Amboyna, and that within a few years one in particular of unusual violence had been felt. It had been accompanied by a hurricane which lasted three days; and during all this time the sea had exceeded its limits, and inundated the country where the town is situated. It is at the change of the monsoons that this scourge is most to be dreaded, and particularly at the beginning of the west mon-

soon, which takes place in these seas in November." It is at the "change of the monsoons," that is, at the beginning and conclusion of the rainy seasons, that the most stormy weather is experienced in India. This is particularly remarked at Ceylon and the Isle of France.

The Asiatic Journal for May 1816 informs us, that several severe shocks of earthquakes were experienced throughout the Moluccas in April of the preceding year, and that the island of Banda had been *extremely unhealthy*.

A letter from Chunar, in Bengal, dated 15th November, 1819, says:—"It has rained here for the last seventy-four hours, without a moment's intermission. A slight shock of an earthquake was felt about 2 P. M. on the morning of the 11th, just as the rain commenced." A letter from Porebunder says: "The equinox was attended with more rain, thunder, and lightning, than I have witnessed for the last ten years. This change in the seasons was accompanied on the 22d, 23d, and 24th (Sept. 1819) with midnight earth-tremors; these ceased with the equinoctial storms." The same writer observes, that a loud *hissing* in the air frequently attended the shocks; and adds, that these noises were extremely awful; in fact, it is scarcely possible to conceive any thing more so. Here we have a part of one of the grandest and most terrific operations of nature exposed to our senses in a very extraordinary manner, and in the midst of storms and darkness, whilst all its impressions are vastly heightened by the great parent of terror—ignorance.

Dr. Heyne, in his "Tracts on India," observes: "These commotions of the earth are never very violent, and by no means frequent, in this country, occurring about once in five years. I felt one at Toomkoor (in Mysore) on the 23d Oct. 1800. It is remarkable that at the same time a violent hurricane raged along the coast from Ongole to Masulipatam. The shock seemed to come from the north, along the inland range of hills. During the violent hurricane at Ongole, just mentioned, large masses of fire were seen to fall upon these

hills, so well known for their influence on the needle, and rain fell at both places during the time in the greatest abundance. These hills are chiefly composed of a kind of magnetic iron-stone." The coincidence between these observations and the following, by the editor of the Madras Courier, is very remarkable. "An earthquake, a phenomenon very unusual, we might, we believe, say almost unprecedented in this part of India, occurred on the 16th inst. (June 1819) in various parts of the peninsula." After describing its effects at Combaconum (in the southern part of the peninsula), he says: "So little known is such a visitation, that the moonsif quotes his Hindoo Shasters as foretelling that an earthquake would sometime happen*. We may here mention, as connected in a manner with the earthquake, *that on the same date a tremendous thunder-storm happened at Masulipatam.* The lightning was terrific, and in the height of the storm the electric fluid struck a bungalow in which were three gentlemen. It is described as 'appearing like *a ball of fire*, which burst with the report of a fourteen-inch shell.' * * * The epidemic still carries off numbers at the Presidency and its vicinity. It is stated to be raging with great violence on the Hoogly among the shipping. No less than three chief officers of ships in the river died of the disease in one day." Another such coincidence occurs in the Asiatic Journal for May 1817:—"Madras, Sept. 24, 1816. During the last week, the neighbourhood of Madras was visited by some severe storms, which however have not had the effect of clearing the sultry atmosphere usually felt so oppressive at this season of the year. About four o'clock on Monday morning, a slight shock of an earthquake was felt at Madras. This phenomenon, so rare on this coast, was followed, on Tuesday night, by one of the most awful storms we ever witnessed."

The person who gives an account of a shock at Mymensing

* The minarets of a mosque at Ahmedabad, which had stood four centuries, were completely thrown down by this earthquake.

on the 15th of November, 1819, states that "the weather for some time before had been cool and clear, but on the 12th it became cloudy and overcast, and the atmosphere heavy and warm*." That of Wallajabad on the 2d of October is stated to have happened on a stormy night with heavy rain, and a flash of lightning was observed at the instant of its occurrence.

The rainy season commences nearly all over India usually about June, and therefore the occurrence of the great earthquake of the 16th of that month (1819) corresponds to that period. The Oriental Star of the 19th of June mentions that "heavy gales of wind had lately prevailed at the head of the bay of Bengal;" and that of July the 3d informs us, that shortly before, a severe storm and inundation had been experienced about Chittagong and Dacca. About this time also the epidemic was raging at many places with great severity.

Mr. Jameson, Secretary to the Medical Board of Bengal, has given a detailed account of the state of the weather at Calcutta, which appears to be connected with the earthquakes that happened there and in other parts of Bengal, on the 11th of November and several subsequent days. "Two or three cold, sharp days (in Oct.), with clear sky and northerly wind, were succeeded by nearly a month of such damp, disagreeable weather, *as to the experienced eye clearly foreboded the return of cholera.* The air was then hazy, raw, cold, and uncomfortable to the feel. The thermometer ranged from 74 to 83, but it felt much colder. There were no sudden variations of temperature. The appearance of the sky was peculiar: it was cloudy, but only partially so. The clouds were not dense, or heavy, or fleeting; but thin and fixed, with frequent breaks, through which the blue sky appeared. They were generally of a dark grey colour, flat, dull, and gloomy; and for several days formed a long, broad, fixed bank towards the west and north-west verge of the horizon, and remained wholly unchanged in shape or

* Calcutta Journal.

appearance*. The wind varied from north-west to north-east. There was seldom regular sunshine. This state of things continued till the 12th, when there was a severe shock of an earthquake, followed by rain and variable winds for several successive days, till the 20th, when a dry cold wind came round from the west, and brought with it a clear sky and regular weather. During the whole of this period of irregularity, numerous cases of the disease occurred, and proved very fatal in Kalinga and other native departments of the town; but no sooner had the season become regular, than the epidemic ceased to be heard of†."

* This appearance of a *fixed* cloud seems to be highly worthy of attention in future observations. A phenomenon of this kind has frequently been observed, on other occasions, to attend not only this and other epidemics, but earthquakes. A single remarkable cloud is likewise a common precursor of hurricanes and thunder-storms.

† "Report on the Epidemic Cholera Morbus, drawn up under the superintendence of the Medical Board of Bengal, by J. Jameson."

This valuable work has reached me during the printing of the present sheet. The separate observations of different persons on any subject cannot be expected perfectly to coincide, much less on one so novel and obscure as this: accordingly I have to regret some disagreements, on points of minor importance, between the facts and inferences which Mr. Jameson has brought forward, and those which I have collected. But the general coincidence is infinitely more remarkable; and I can appeal with perfect confidence to Mr. Jameson's work for support to the views which I have taken of the nature and causes of the disease. The most prominent part of Mr. J.'s inferences regarding the great remote cause, is its connection with the *irregularity* and intemperature of the seasons, which have marked the years in which it has prevailed; and throughout the work the immediate connection of the disease with stormy, rainy, cloudy, or hazy states of the atmosphere is rendered evident by a great number of facts, equally conclusive with the most striking of those which I have adduced. The numerous instances there recorded of the disappearance of the disease *after* heavy rain, and on the return of serene states of the atmosphere, are equally remarkable.

A reflection has been thrown on the profession in India by the editor of the Medico-Chirurgical Journal and Review (May, 1817), who

Mr. Boyle relates, that an earthquake took place in England, in January 1666, immediately after a change in the weather from settled frost to rain, and that "soon after" there happened a brisk storm*. On another occasion he mentions that the weather before an earthquake was "so rainy, that most people were apprehensive of a flood." At p. 604, vol. iii, of the same work, an earthquake is mentioned, preceded by the appearance of a bright light, like a fire, which vanished at the moment of the shock. Another very violent one, happening January 11, 1692-3, was preceded by great darkness. "South winds prevailed very much, and have always been impetuous in the most considerable earthquakes. The effects on human bodies have been various; such as foolishness, madness, hypochondriac, melancholic, and *choleric* distempers. Fevers have been very common, with many continual, tertian, malignant, and mortal ones in great numbers, with delirium and lethargy. The small-pox has made great destruction among children: in short, every age and condition has had its share in so universal a calamity." Some very dreadful earthquakes in Sicily about the same time, were preceded by an unusually stormy and rainy season. Another at Naples, March 9, 1730-1, was accompanied by "an atmosphere overcharged with *dense, low, immoveable clouds*, which shortly afterwards disappeared." It was preceded by coruscations about a mountain in the neighbourhood†.

"bewails the spell that enthrals the minds of his medical brethren in the East, and despairs of breaking it." A work so replete with evidence both of industry and talent as that of Mr. Jameson, is sufficient in a great measure to remove this (it must be confessed not undeserved) opprobrium. The spirit of active inquiry, however it may have slept, appears to be now thoroughly awakened. It has already collected an immense number of important data regarding this epidemic; and there is every reason to hope that it will not rest until the causes and pathology of the disease are completely elucidated.

* Phil. Trans. Abridgment, vol. i, p. 50.

† Ibid. vol. vii, p. 46, 182.

Dr. Bayley, in the same work, describes an earthquake which happened in England in 1734; and remarks, that the phenomena which happened before and after it, agreed with the signs which have been observed to attend former earthquakes. These were, much rain and wind for some months previous, frost. The night on which it happened was very rainy, and a strong gale of wind arose within a quarter or half an hour after the shock. The next article mentions another, which was accompanied by a flash of lightning. Dr. Chandler* mentions an earthquake occurring at the conclusion of a violent thunder-storm. At Maestricht upwards of eighty shocks were felt in 1756; and it is observed, that "during the most violent shakings, there were some kinds of flashes of lightning†." Dr. Hales witnessed a rushing noise and loud explosion in the air, at the time of an earthquake in England; others observed a black cloud and lightning a little before. He adds, that "in the history of earthquakes it is generally observed that they begin in calm weather, with a black cloud‡."

Webster records, that a thick fog overspread the island of Sicily on the 5th of February, 1783, the day on which it was nearly destroyed by earthquakes; and that flames were seen to issue from the sea at the times of their occurrence. He likewise says: "as hurricanes are occasioned by discharges of electricity, some trembling of the earth almost always attends those which are violent, and flashes of fire are visible. Indeed the atmosphere appears to be a sheet of fire. Similar discharges of electricity attended the tempestuous earthquake which destroyed Nicomedia in 358. The same took place in the earthquake which defeated Julian's attempt to rebuild Jerusalem in 362. The same took place in the terrible hail storm in Egypt during Pharaoh's reign. A similar instance will be hereafter related to have happened in Italy in 1785.

* Philosophical Transactions, Abridgment, vol. xii, p. 190.

† Ibid. vol. xi, p. 190.

‡ Ibid. vol. x, p. 110.

* * * On the 17th of January, 1784, a terrible tempest spread desolation along the coasts of France, Spain, and Portugal. An earthquake accompanied this hurricane. The coast of Italy did not escape; and so high was the swell of the ocean, that the fish were lodged in the houses of Syracuse*."

Both earthquakes and storms are more frequent and violent in tropical than in temperate climates; and the quantity of rain of the former is much greater than that of the latter countries. It has likewise been observed, that earthquakes generally occur in years which are marked by great deviations from the usual states of the seasons, storms, &c.; and this coincidence is strongly exemplified by the late occurrences in India. It is farther remarkable, that not one of the above-mentioned earthquakes in India have happened in the most generally serene quarter of the year, that is, in December, January, or February.

Dr. Finlayson, in giving a relation of many earthquakes which happened in Scotland in 1789, and several subsequent years, remarks: "From the above account it will be observed, that all the greater shocks have taken place in the season of autumn or beginning of winter; that this has now been repeated for more than four years; and that those greater shocks have been succeeded at short intervals by rumbling noises or more feeble concussions. It has also been remarked, that they have in general been preceded or followed by great rains or boisterous weather." Autumn and the beginning of winter are well known to be the most unhealthy part of the year; and they appear to be also the most stormy and rainy. One of these earthquakes is stated to have happened in a perfect calm, during which many sudden variations of the barometer were observed, followed in a few hours by a very violent tempest. Another shock took place when the weather was calm and hazy. A third was felt "during a violent

* History of Epidemics, vol. i, p. 438, 442, 452.

storm of wind and rain, which continued the whole day, and was at its height at the time of the earthquake*. Many similar coincidences have been related as occurring in India: another may be added. A letter from Kaira, dated 24th of July, 1819, states, " We had last night a heavy fall of rain, accompanied by thunder and lightning. The lightning killed a dragoon of His Majesty's 17th. About half past ten there was a slight shock of an earthquake." During a violent earthquake in Italy in 1638, a person at a distance observed the city of Euphemia entirely hid by a thick, black cloud, which rested over the place, whilst the sky all around was calm and serene. On the disappearance of the cloud, the city was found to be totally sunk, and where it formerly stood nothing remained but a dismal and putrid lake. A similar phenomenon was observed over the city of Catania, when it was destroyed by an earthquake in 1693. The great earthquake of Lisbon was preceded by an unusually wet season. On the day before it happened the sun was obscured, and a general gloom prevailed over the atmosphere. On the morning of its occurrence a thick fog arose, during a perfect calm†. An earthquake which occurred in Austria, on the 4th of July, 1819, is said (in the public prints) to have been preceded by insupportable heat, and stormy and rainy weather. The Abbe Rochon, in speaking of the hurricanes of the Isle of France, says: " A hurricane is almost always accompanied by rain, thunder, *and an earthquake*‡."

Thus it appears, that the circumstances which attend earthquakes are similar to those that attend epidemical attacks of cholera—cloudy, rainy, hazy, or stormy states of the atmosphere, or at least an evident *tendency* to those states; for the calm and clearness of the air which commonly precedes earthquakes, appear to be but that delusive serenity which precedes

* Encyclopedia Britannica. † Ibid.
‡ Voyage to Madagascar, &c.

a hurricane. We have sufficient evidence that the state of the atmosphere which precedes earthquakes, like that which accompanies cholera, is oppressive to the feelings, particularly of invalids; and it is universally observed that the lower animals shew signs of great uneasiness at these times, such as we see them exhibit before storms.

The opinion of the connection of earthquakes, not only with disturbed states of the atmosphere but with diseases, receives a singular degree of countenance from the fact, which appears to be thoroughly ascertained by the researches of Mosely, Webster, and others, that these convulsions most frequently happen about the full and change of the moon. This circumstance has likewise been observed in India. The writer of a letter from Booj says, concerning the late earthquakes there: "The shocks generally happen about the springs, and the people here are fully persuaded that they are occasioned by them."

The causes of earthquakes are not clearly explained, but the most general opinion regarding them, in the present day, appears to be, that they are produced by electricity. Dr. Stukely has adduced many arguments in support of this opinion. He observes:—"Previous to the earthquakes in London, in 1749 and 1750, the aurora borealis had been very frequent, and a very short time before the earthquake, exhibiting unusual colours, and its motions were to the south, contrary to its usual direction. During this year, too, fireballs, lightnings, and coruscations had been common; and on the night preceding the earthquake, coruscations were frequent. From these circumstances an earthquake was predicted by the Italians and others, who had been accustomed to the appearances which precede them. Before the earthquake came on, a *black cloud* suddenly covered the atmosphere to a great extent. Another argument in favour of the electrical hypothesis is drawn from the effects of the earthquake on the state of the weather at the time, and on persons

of weak and nervous constitutions. To some these disorders proved at the time fatal; and its effects in general were similar to those of artificial electricity *."

Dr. Priestley has imitated the tremulous motion of earthquakes by electricity. The noise which accompanies them is also said to be in support of this hypothesis, and not to be accounted for on any other.

Another very strong argument in favour of the electric theory of earthquakes arises from the simultaneous occurrence of the same shock at very distant places. Dr. Stukely observed, that a portion of earth in England one hundred miles in length, was pervaded (as far as could be learnt) in an instant. M. De Humboldt informs us, that "often on the coasts of the South Sea, the action is almost instantaneously communicated from Chili to the gulf of Guayaquil, a distance of six hundred leagues." It has been a matter of general remark (and that uninfluenced by theory), that the earthquake of the 16th of June, 1819, took place all over India at the same moment. Some of the observations on which this conclusion is formed must necessarily be somewhat uncertain, from their casual nature, the imperfection of watches, and the different methods of keeping time at different places; but notwithstanding this, it is found that they very nearly agree in referring the event to the same point of time: the differences of time arising from differences of longitude (at four minutes to the degree) very nearly corresponding to the observed differences of time at numerous distant places. This inquiry has been entered into at full in a paper, signed "Terrestris," which has appeared in the public prints (but which well deserves a better fate); and the writer comes to the following conclusion: —

"Here it is demonstrated, that an instantaneous throe is felt over twelve or thirteen hundred miles of the earth's surface, from a given point of greatest agitation, in an easterly

* Encyclopedia Britannica.

direction. If from analogy you suppose it to have been felt to an equal extent in a westerly, &c.; about three thousand miles of the earth's surface, in all directions, is moved in the twinkling of an eye—BY WHAT?"

The only opinion of the cause of earthquakes which stands in opposition to that of electricity, supposes them to be produced by the formation of *steam*, or some analogous process, by which an elastic gas is produced, or brought into action. On this hypothesis it is necessary to suppose that the action originally takes place at a single spot, whence the effect is communicated by concussion or vibration through the earth to distant places. This communication cannot be instantaneous. Sound itself in travelling twelve or fifteen hundred miles (if it were possible) through the mobile and elastic air, would require about two hours; and we cannot suppose that any analogous motion could take place, through the solid and inelastic earth, in so short a time. But the escape of elastic gas or steam during earthquakes has never been distinctly observed. The effects of earthquakes do not bear the most distant resemblance to the springing of mines, or the eruptions of volcanoes. The former are not attended with the projection of bodies from the surface of the earth, or the formation of craters. And surely, an explosion from the escape of elastic fluid taking place in Kattiwar, must have been sufficient to throw large portions of that peninsula into the air, if it was sufficiently strong to be felt in Nepaul and at Cape Comorin. But what power in nature, except electricity, can we suppose to be capable of agitating the whole of India in an instant? Electricity, however, is equal to this; for, as far as our knowledge of that wonderful fluid extends, its power appears infinite, and its motions instantaneous.

One of the strongest arguments in favour of the hypothesis which is here combated, is derived from the connection which frequently exists between earthquakes and *volcanoes*: but where is there a volcano in India with which these earthquakes can have had any connection? It may be likewise

observed, that this hypothesis affords no explanation of the connection between earthquakes and epidemics; for we cannot suppose that the escape of steam into the air, much less the circumstance of its being about to be formed, can produce these visitations. And this argument is not a *petitio principii;* for that connection is too well proved to require my feeble efforts to establish it.

The objection to the hypothesis of earthquakes being produced by the action of elastic fluids, which exists in their simultaneous occurrence at distant places, has been attempted to be obviated by the supposition that the action takes place at great distances from the surface of the earth. Thus, if we suppose that the concussion of the 16th of June, 1819, was originally produced at the distance of twelve or fifteen hundred miles beneath the Peninsula of Guzerat, it might be felt at the same time in Nepaul, at Cape Comorin, and in Persia, although it required many hours to reach those places; but it would still appear earlier at Guzerat than the last mentioned places. If that earthquake appeared at the same time at all the places where it was felt, and if it originated at a certain point, and required a sensible time, in proportion to the distances to be communicated, there is no other way of accounting for the facts than supposing that it occurred at the centre of the earth; for there is no other point equidistant from all those places. And the same supposition is necessary on that hypothesis, in the case of every earthquake which appears at the same time at various distant places. It cannot be denied, that a power arising from the expansion of elastic fluids may exist, which is equal to tearing up or agitating such immense portions of solid earth; but it is evident that it must be in proportion to the quantity of gravitation and cohesion which it thus disturbs or overcomes; and, therefore, the quantity of elastic fluid required must be inconceivably great. And the effect cannot be produced until the agent actually assumes the elastic form, expands, or escapes, however great may be its effort to do so; for the condensed air in an air-

gun, however great its *power*, produces no *action* until it escapes. Yet the escape of ponderable elastic fluids during earthquakes has no foundation but in hypothesis. That opinion is likewise entirely inconsistent with the connection between earthquakes, previous states of the atmosphere, and diseases; and is a mere hypothesis to outweigh the united observations of all ages!

Few observations have been made public regarding the phenomena attending the late earthquakes in India, but several of these tend to confirm the electrical hypothesis. In several places the hissing noise in the air, which frequently attends earthquakes, has been distinctly noticed. At Porebunder it was said to resemble "the near and rapid flight of twenty or thirty strong-winged pigeons." In various instances effects on the human frame, similar to those already recorded, have been found to attend these occurrences in India; as vertigo and sickness at stomach.

Lightning and the aurora borealis, which are evidently electric meteors, are well known to disturb the direction of the magnetic needle; and such has been observed to be the case with earthquakes*. A hissing noise has occasionally been noticed attending the aurora; such likewise is the case with earthquakes; and it is doubtless produced by the rapid passage of electric fluid through the air. A sulphureous smell has often been remarked during earthquakes; and it is well known that that is a constant attendant on electrical discharges. It is true that flashes of light have not been constantly observed to attend earthquakes; but there is reason to believe that this appearance does not invariably accompany great electrical discharges. Mr. Brydone, in the seventy-seventh volume of the Philosophical Transactions, gives an account of a violent stroke of thunder which was unattended by lightning. At the time of its occurrence he was engaged in measuring the distance of time between each flash and the arrival of the

* Encyclopedia Britannica, article Variation.

sound; and noticed a very loud stroke which was not preceded by the flash. It resembled the firing of several muskets so close together, that the ear could scarcely separate the sounds, and was followed by no rumbling noise like the other claps. At this time a man and two horses in a cart were struck dead, and the ground torn up at the place. Two other persons, at different places and small distances, saw the fall of the man and horses, heard the thunder-stroke, and agreed that there was no flash. Mr. Brydone farther observes, "*The equilibrium between the earth and the atmosphere seems at this instant to have been completely restored; for no farther appearance of thunder or lightning was observed in our hemisphere; the clouds dispelled, and the air resumed the most perfect tranquillity;* but how this vast quantity of electric matter could be discharged from one element into the other without any appearance of fire, I shall not pretend to examine." A gentleman observed *a sensible tremor* of the ground a little before the accident; and though this was not noticed at the time of the explosion, it is probable that this discharge was of the kind which usually produces earthquakes.

The connection between earthquakes and changes in the atmosphere has been denied, because they have often been observed at particular places to occur under very different states of the weather, and unattended by any evident changes in it. The electrical theory necessarily supposes that a great change in the atmosphere takes place *at some part of it*, previous to and during every earthquake; but if we suppose that the electrical discharge which produced the earthquake of the 16th of June, 1819, took place in the neighbourhood of Booj, it is nugatory to say, because a remarkable change was not observed in the air all over India about the same time, that the phenomenon was unconnected with the atmosphere. Earth and water are conductors of electricity, and air a non-conductor, or imperfect conductor; therefore the effects on the former must be much more extensive

than those on the latter. This theory likewise affords an explanation of the circumstance which has occasionally been noticed (particularly in India, on the 16th of June), of two or more places suffering severely from a shock which is scarcely felt at an intermediate place. The different strata of the earth, doubtless, possess different powers of conducting electricity. M. De Humboldt has observed, that the workmen in the mines of Saxony have hastened up, affrighted at oscillations which have not been felt at the surface of the ground. It has also been generally remarked, that earthquakes are communicated along rivers, sea-coasts, &c.; and that their existence is indicated much more extensively by water than by land; vessels at sea receiving a sudden shock, as if they had struck on a rock*. These circumstances are precisely such as were to be expected on the electrical theory; for water is a much better conductor than earth; and they are all diametrically in opposition to the opinion of simple concussion producing the phenomena.

It appears, then, very plainly, that an earthquake is produced by a discharge of electricity; and as all electrical discharges consist of the passage of a portion of the fluid from places where it exists in greater quantity, to others in which it exists in less quantity, the great question of the cause of earthquakes appears to be, where is the abundance, and where the deficiency of this principle which gives rise to them? Dr. Stukely maintains, that this want of equilibrium of electricity exists between the earth and the atmosphere; and this opinion appears so strongly supported, that little doubt can remain of its truth. The electric fluid continually diffuses itself equally, and maintains its equilibrium throughout conducting bodies, unless prevented by the intervention of non-conductors; and as the earth, in its usual state, is a conductor of electricity, it is difficult or impossible to suppose that such an accumulation in any part of it, and deficiency in another

* Encyclopedia Britannica.

neighbouring part, can exist as to produce a discharge between them. Beccaria supposes, that "the electric matter to which these phenomena are owing is lodged deep in the earth; and that it is this matter, discharged from the earth to restore the equilibrium or *deficiency which the clouds have sustained* during thunder-storms by giving out their electrical matter to another part of the earth. This, he supposes, is confirmed by the noise resembling thunder, and the flashes of lightning which are perceived during earthquakes*."

On these or similar grounds the phenomena may be very satisfactorily accounted for. Large portions of the upper regions of the atmosphere, in the negative state of electricity, and from rarefaction possessed of considerable conducting power, probably communicate with the earth at some point or points, by means of a shower of rain, or in some other way, whence the discharge takes place; the electric fluid rushing into these points from neighbouring parts of the earth, with a violence chiefly in proportion to their nearness to the place; whence the concussion and vibration necessarily follow, as observed in electrical experiments†.

The simultaneous occurrence of heavy clouds, rain and storms, with earthquakes, is in support of this opinion, on the preceding principles; as they indicate deficiency of electric fluid in the atmosphere, or portions of it: and if the hypothesis shall be established, the occurrence of earthquakes will likewise indicate this deficiency; and their connection with the epidemic cholera will argue that the disease depends on this cause.

But the force of evidence which this part of the subject affords, authorizes a less diffident style. The connection of

* Encyclopedia Britannica.

† Is not the great prevalence of earthquakes in the neighbourhood of volcanoes in a great measure owing to the latter forming a ready means of communication between the earth and higher regions of the atmosphere? It is well known that heated air and flame are excellent conductors of electricity.

earthquakes with epidemics has been generally observed and believed by writers on these diseases, and, as far as my reading extends, is not denied by any. Or, if the reader is unwilling to form his judgment on the *opinions* of others, let him examine the immense mass of *facts* which they adduce, and the result must be conviction. In the present instance this relation is exemplified in the clearest manner; for we have seen numerous earthquakes attending the epidemic cholera, in a country where they are nearly as rare as in England. It scarcely admits of a rational doubt that earthquakes are owing to electricity. Here then we have the important fact strongly proved, of a connection between the disease and an electrical phenomenon on the largest scale. This connection evidently points to one of two conclusions: that the disease is owing to the earthquakes: or that both are collateral effects of a common cause. The first of these suppositions has been commonly adopted in similar cases; but it has frequently been found that the diseases have preceded the earthquakes; and such has been the case, in general, in the present instance. We are therefore irresistibly led to the other inference; and it becomes evident, that if we possessed a perfect knowledge of the cause of the late earthquakes in India, we should have arrived at that of the epidemic. The only satisfactory theory of earthquakes which we possess, makes them depend on a deficiency of electric fluid in the atmosphere; and almost every circumstance attending both them and the epidemic, leads to the conclusion that such is their common cause.

Is not then an earthquake a mighty means, in the hands of Providence, of restoring the salubrity and serenity of the atmosphere, by replenishing it with electric fluid? Van Swieten, in speaking of the opinion of plagues arising from earthquakes, says:—"On the contrary, when the plague raged at Oczakow, on the very day the distemper began to abate, a violent earthquake happened." Quere, "*Did any thing exhale from the earthquake antidotal to the contagion of the*

plague?*" M. De Humboldt observes, "that often when violent shocks succeed each other in the space of a few hours, *the electricity of the air*† *sensibly increases at the instant that the ground is most agitated.*" These are eloquent facts.

The evidence of Webster tends to show, that earthquakes have the effect rather of removing than producing epidemics. "It seldom happens that a pestilence can be traced directly to earthquakes. On the other hand, although great plagues are almost invariably accompanied with shocks of the earth, yet it more usually happens that the pestilence appears before the concussion. Thus the shocks which alarmed and laid waste Italy in 1348, 1349, and 1350, were preceded by the dreadful plague of 1347‡."

"In the well-known plague at Oczakow in 1738 and 1739, an earthquake happened about the time the disease began to abate. Such was the fact in the days of Thucydides§. Numerous observations on these phenomena lead me to suspect, that the fire which is to produce the explosion is in violent action for a considerable time before the shock; and that it is the previous action which occasions epidemic diseases.

"The earthquakes do not always occur in the seat of pestilence. I find no concussion mentioned to have happened at London in 1665, or in the years next preceding or following; but shocks were experienced in the neighbouring countries in 1665 and 1666.

* Commentaries, vol. xvi, p. 36.

† "See the electroscopical experiments made in Piedmont, in the vallies of Pelis and Cluson, in 1808. Journal de Phys., t. lxi, p. 292." Personal Narrative of Travels in South America, vol. ii, p. 238.

‡ This plague is perhaps the most general and destructive of all that are mentioned in history. It is said to have begun in China, in 1346, and to have extended gradually and progressively over the whole world westward. It ceased in 1350. It is remarkable that most of the great general pestilences recorded in history have arisen in the east and spread to the west.

§ The anomalous plague of Athens, between which and cholera I have attempted to trace an analogy, is here alluded to.

" It has been ascertained beyond all question, that the periods of extensive pestilence and extensive mortality are remarkable for earthquakes and eruptions of volcanoes. But the explosions do not so generally *precede* epidemics as to authorize the supposition that they *produce* these diseases. Earthquakes occur during the prevalence of pestilential, or other mortal epidemics, but in the midst of the period, or sometimes at the conclusion*."

" The various sounds or noises which precede and attend earthquakes are a strong confirmation of these ideas" (of the electrical origin of earthquakes). " The usual premonitory sound is compared to the rattling of carriages on a pavement. Sometimes it is described as the rumbling of distant thunder. It is most analogous when near to the rattling sound from the near explosion of the electric fluid; as those can testify who have been near the place where lightning has fallen upon objects. It bears no resemblance to the artificial sounds made by the explosion of gunpowder, or other human contrivances. It is most unquestionably the effect of the electrical fluid rushing from one part of our system to another — probably *from the earth to the atmosphere — to restore the equilibrium which has been by some means destroyed,* or to answer other unknown purposes*."

It is evident from a foregoing extract, that the *last* earthquakes in Bengal have been quickly followed by the disappearance of the very unusual state of the atmosphere (for the time of the year), which then prevailed — by the return of a serene sky, and the vanishing of the epidemic.

That epidemics do not always disappear, but, on the contrary, often increase *after* earthquakes, is no argument against this theory. A famine in a country may increase notwithstanding the importation of a supply of corn. The same reasoning may be applied to explain the facts of rain and storms occasionally *following* earthquakes. But our knowledge of meteorology, as well as of the animal economy, is

* History of Epidemics, vol. ii, p. 132—136.

† Ibid. vol. ii, p. 152.

too limited to enable us to explain all their phenomena, even on *true*, but imperfect theories. The theory of gravitation itself does not, even yet, satisfactorily explain all the movements which are believed to depend on it.

From analogy we have every reason to expect, that former severe visitations of epidemical diseases in India, will be found to have been attended by earthquakes. I have not yet attempted to ascertain this point, but one remarkable instance of such coincidence has cursorily occurred to me. Dr. Lind mentions "a great sickness, of which it was computed that thirty thousand blacks and eight hundred Europeans died in the province of Bengal, in the year 1762;" which nearly agrees in point of time with some vague accounts extant, of a former prevalence of epidemic cholera in the peninsula*; and an article in the Philosophical Transactions (vol. xii, p. 11, Abridgment) records several earthquakes of extreme violence, which happened in Pegu and Ava, from the 2d to the 19th of April of the same year. And at p. 190, of the same volume, is an account of a severe plague all over the Ottoman empire in that year, *attended there, likewise, by many earthquakes.*

Has not the *pestilential period*, beginning in 1817, which has been marked by the prevalence of epidemical diseases in many parts of Europe, Africa, and America, almost as much as in India, been also attended by numerous earthquakes, storms, and other indications of an unusual state of the atmosphere, in these countries as well as in India?

I trust it has been shown, as clearly as the imperfection of our data and knowledge of the subject will admit, that a deficiency of free electric fluid in the air accompanies the

* It appears that this was actually cholera. M. Keraudren states that "an analogous epidemic raged in Bengal in 1762. The most dreadful symptoms were, according to Le Begue de Presle, continual vomiting of pituita, or thick white transparent phlegm."

attacks of this epidemic. I have now to endeavour to prove, that that state actually forms the great cause of the disease; and to essay an explanation of the manner in which it acts on the living system and produces the disease.

In this inquiry into the origin of the epidemic, I have hitherto proceeded without making any postulates which are not generally admitted, and therefore without diffidence; but it is evident that the undertaking cannot be completed without involving principles of a more unauthorized nature. The foregoing general inferences appear to be so thoroughly borne out, both by legitimate theory and observation, that I cannot help considering them in a great measure as established facts; the remaining part of the subject must necessarily assume more of the form of hypothesis and conjecture.

Of the importance of electricity as a natural agent but one opinion can be maintained, that it is incomparably the most active and most momentous principle in the whole physical world. It combines the celerity of light with a chemical power much greater than that of caloric; and by its great and peculiar property of giving attraction and repulsion to other substances, it becomes an infinite source of motion. Accordingly we find that scientific men, in speaking of its general agency, have been carried almost beyond the bounds of the sober language of philosophy.

"Its effects are so many and various, that it may be said without much exaggeration, that, whether we look to the heavens above or to the earth beneath, we can scarcely perceive any thing that is not acted upon, and in a manner subjected to the operations of this wonderful fluid*."

"Though often, Proteus-like, it eludes our grasp, plays with our curiosity, tempts inquiry by fallacious appearances, and attacks our weakness under so many perplexing subtleties, yet it is impossible not to believe it the soul of the material world, and the paragon of elements†."

* Encyclopedia Britannica. † Walker.

These observations, however, appear to be justified by the views which have lately been generally taken, of the agency of electricity in both organized and unorganized matter; for there is great reason to believe, that it is on this principle that all life, whether animal or vegetable, and all chemical affinity, immediately depend; and consequently, that, were it to be entirely abstracted, the whole creation would be transformed from the beautiful scene which it now presents to its original condition of a senseless and motionless chaos.

Ever since the discoveries of Galvani, it has been believed by many, that the nervous fluid and the principle of life are identical with the electric fluid; and these are not the opinions of romantic and speculative men alone: the researches of two of the most eminent medical philosophers whom the science has to boast of, John Hunter and Mr. Abernethy, strongly tend to prove, that the principle of life has a physical existence; — that the phenomena of life are owing to the presence of a subtile but material fluid. The latter author has shown, as far as the imperfect knowledge we possess of these abstruse subjects would permit, the complete analogy which exists between this principle and electricity; and it is evident that it is but the caution which is characteristic of true philosophy, which has prevented his inferring their identity. These important discoveries have not, indeed, been universally credited; but they have surely been more denied than disproved, and appear to be daily gaining ground in the present improving state of science. If, then, a deficiency of electric fluid in the atmosphere accompanies the prevalence of the disease, and the disease itself consists of a deficiency of nervous influence, that is, probably, of the nervous or electric fluid in that portion of our frame; it becomes extremely probable, *a priori*, that the former state produces the latter.

It is not, however, on arguments of this general nature that this explanation of the production of cholera is chiefly to rest. One principal link in the chain of reasoning appears to

be still wanting: "*In what manner* does the deficiency of electric fluid in the air produce the corresponding deficiency in the animal frame?" It must be allowed that this question would appear to be satisfactorily answered, and all the foregoing views strongly supported, if it shall be proved, that *the blood is continually receiving a supply of electric fluid from the atmosphere*, and that that supply is necessary to the state of health.

Mr. Read has proved by experiment, that *the air becomes changed from the positive to the negative state of electricity by respiration**; and Volta has confirmed this inference†. The general principle of the absorption of electricity by the blood, in its change from venous to arterial in the lungs, is likewise assumed or considered probable, by various respectable authors‡; and though the facts on which it rests may be few and little noticed, it is not to be supposed, that, if they did not exist, so important an error would have remained so long undetected. But the known accuracy of Read and Volta render any arguments of this kind unnecessary.

It is an established axiom in physiology, that the use of respiration in the animal economy is to accomplish the change in the blood from the venous to the arterial state; and that the principles which the air loses in respiration are received by the blood, whilst those which the air gains in the process are given out by the blood, during the change it undergoes. It appears to follow, therefore, that the electric fluid which disappears from the air enters into the blood.

Nature does nothing in vain. There is no substance in the whole animal economy with which we are acquainted, that does not answer some important end; and we cannot for an instant suppose, that the most active and powerful principle in nature can thus be constantly taken into the system to remain in it inactive and useless. It may then be strictly inferred,

* Philosophical Transactions.

† Wilkinson's Elements of Galvanism.

‡ Mr. Wilkinson, Dr. Robertson, and M. Richerand.

that this supply of electricity is *necessary* to the animal economy; and that the diminution and suppression of it may produce disease or death.

It remains for future observation and experiment to prove the truth or fallacy of these assumptions, by determining whether the respiration of a positively electrical atmosphere is not favourable, and the opposite state injurious to animal life? Some striking facts may however be adduced in support of this position.

It has constantly been found, that animals confined in portions of air, die before the whole of the oxygen gas in the air is consumed; and Sir H. Davy has found that a mouse, enclosed in a mixture of 10.5 cubic inches of oxygen gas and 3 inches of nitrogen gas, died when 2.1 inches of oxygen gas only had been consumed; consequently, in an atmosphere much richer in oxygen than common air: and it is found that this circumstance is not owing to the excess of carbonic acid gas produced in respiration, for similar results are obtained when that fluid is abstracted by alkaline liquors. It is evident, then, that the presence of oxygen gas, even in great abundance, is not sufficient for respiration.

Mr. Boyle introduced animals into the receiver of an air-pump, and abstracted various portions of the air from them. On the very commencement of the rarefaction they showed signs of great uneasiness; subsequently they vomited, became convulsed (other accounts of similar experiments mention that they discharged their feces). On stopping the rarefaction before it had proceeded to any great height, in some instances they gradually recovered. The last circumstance appears to be unaccounted for; for the stoppage of the process did not restore the deficiency of air. On the foregoing principles, the rarefaction must necessarily have reduced the air to the negative state of electricity; and the condensation of vapour which takes place at the same time, and which produces "a *perfect shower* falling on the pump plate," is in proof of this deficiency of electricity. The latter phenomenon has been

attributed to the cold which is likewise produced by the same process; but this amounts to no more than three or four degrees of the thermometer; and the introduction of a piece of ice into the receiver would equally depress that instrument, without producing this miniature resemblance of a shower of rain. On the cessation of the rarefaction, the deficient electricity would probably be restored from the surrounding bodies, and the animal would recover; and we accordingly find that the condensed vapour becomes rapidly reabsorbed when the rarefying process is interrupted.

The analogy between the affections of the animals in this instance and cholera cannot but strike the most inattentive reader. In fact, this simple experiment may probably be considered as a perfect instance of the simultaneous production of *cloud, rain,* and *cholera,* in miniature, from deficiency of electric fluid, bearing the strongest analogy to the process which takes place on a general attack of the epidemic. Mr. Jameson has shown, that inferior animals have frequently suffered severely from a disorder bearing every resemblance to cholera, whilst that disease was committing its ravages among the human species.

It may, however, be alleged, that the injurious effects experienced by the animal under this experiment are entirely owing to the great rarity of the air, or to the *sudden* transition from dense to rare air; and that its recovery is in consequence of time being permitted for it to become familiarized to the change. But what will become of this argument when it is found, that even a human being may bear, nay be almost instantly transported to an atmosphere much more rare than that which kills the animal, without suffering any inconvenience?

"But though artificial compression of the air, as well as natural rarefaction, *may be thus borne, it is otherwise with artificial rarefaction.* Animals in an air-pump show uneasiness from the very first, and cannot live for any time in an atmosphere rarefied artificially, even as much as it appeared

to be from the barometer on the top of Mont Blanc*. What other explanation than that which is here offered can be given of this striking fact?

The French mathematicians on the Andes did not find their breathing oppressed *except when enveloped in clouds*†. This is a strong fact in support of the theory; for clouds are found generally, if not constantly, negatively electric. In the accounts of aeronauts, likewise, we nowhere meet with any mention of difficulty of respiration in the higher regions of the atmosphere. Mr. Baldwin expressly says, on one occasion, that when at his greatest height he found his breathing perfectly free and easy. In one part of this voyage the earth appeared to him to be seven miles distant, though the barometer indicated but one and a half. Professor Robertson ascended into the atmosphere at the amazing velocity of fifty feet per second, and consequently in a few minutes found the barometer at fifteen inches. "He set at liberty two pigeons, which descended with the rapidity of lightning, without moving their wings, and in a plane very slightly inclined. When the barometer stood at fourteen inches, he let off a third pigeon, which having fluttered about for a moment with difficulty, perched on the net-work, and would not quit it. Two butterflies let go at the same time tried to use their wings, but in vain, as the air was too rare; they never quitted the car, and fluttered, but in a very feeble manner. By means of a very ingenious instrument, invented by Mr. Hez, mechanician, he inclosed four inches of the surrounding air, along with mercury, and marked exactly the point where the air and mercury were united. When he reached the earth he found that the latter filled the whole tube within a tenth. This important experiment seems to prove, that in the upper regions there exists nothing but vapours, and no atmospheric air. If this conjecture of Mr. Robertson be verified, there will be no reason why people may not ascend to a much

* Encyclopedia Britannica.

† De Ulloa's Voyage, vol. i, p. 217.

greater height than 3670 toises, to which we know some have ascended*."

The result of the experiment on the density of the air is altogether so surprising as almost to stagger belief. There is however no reason to doubt its accuracy. It proves in the clearest manner, that an atmosphere possessing but one-tenth of the quantity of oxygen which exists on the surface of the earth, and, as far as permanently elastic gases are concerned, but one-tenth of its density, may be breathed without inconvenience. Is it not evident, then, that some principle must exist in the higher regions of the atmosphere which *supplies the place* of oxygen gas, so necessary to respiration in ordinary circumstances? Electricians appear to have informed us what this principle is by the observation, which they seem to have unanimously made, that the electric fluid is most abundant in the upper regions of the air.

Accordingly we find that air, as it exists in its natural state of rarefaction on the tops of mountains, possesses properties diametrically opposite to those of air which actually undergoes a change from dense to rare, either by artificial or natural means. Saussure has observed, that "when rarefied air is breathed" (on mountains) "the nervous system experiences a kind of excitement; agreeable sensations are produced, with a disposition to cheerfulness." The healthiness of high situations is proverbial; and it will subsequently be seen that this disease has been found particularly to affect low situations, and to disappear on the removal to higher parts. This fact is one of the most evident of all that experience has brought to light regarding the relations of this epidemic. I find it has been almost invariably observed in Bengal, as recorded by Mr. Jameson, in accordance with a great number of instances in proof of it, which I had collected on this side of India. Even small degrees of elevation are frequently found to occasion great differences in the prevalence of the disease.

* Tilloch's Philosophical Magazine, vol. xvi.

Such is the case with the electrical states of the atmosphere; for the height of a building has been found to occasion a very remarkable difference in the marks of electricity in the air.

It has also been constantly found, that filthy, close, and ill-ventilated situations have suffered from the disease much more than others: and such, likewise, are the situations in which the weakest positive, or negative electricity are met with. Read found the air at one end of a school-room, which was *situated over a common sewer, and gave an ill smell,* negatively electric, whilst the open air, and even the other end of the room, were in the opposite state. "When Mr. Read worked the doubler of electricity in a close room, in which people had been shut up for a certain time, or upon a dung-hill, or in a privy, he obtained negative electricity; but when he worked it in the open and clear air, the result was positive electricity*." The positive electricity of the air is always found stronger in open and airy situations than in the streets of cities, among trees, &c. Many farther arguments of this kind might be adduced, but I trust enough has been said to excite such inquiry as must quickly and finally decide the question of the truth or fallacy of these speculations.

On these grounds a reasonable expectation may be formed, that an atmosphere positively electrified by art will be found favourable to respiration; but should it be proved that this is not the case, it will be insufficient to overthrow the mass of evidence which has been adduced. We know too little of the nature of the electric fluid to be able to affirm that the electricity produced by the machine is identical, or in the same state, with that which is taken into the frame in respiration. Electricity is known to be capable of various modifications; for in the galvanic process one if not two fluids are produced, which, though they resemble the electricity of the machine in their principal features, yet possess some properties extremely different. The electricity which arises from

* Cavallo on Electricity, vol. iii, p. 86.

friction is said to consist of the fluid in a highly elastic or repulsive state, and little capable of entering into chemical combination; whence it is to be apprehended that its presence in the air may not influence respiration.

The changes on the air produced by the respiration of animals, are, as far as experiments have reached, the same as those produced in an analogous process by vegetables; whence it may be expected that similar changes in the atmosphere will somewhat similarly affect both these classes of organized bodies: and hence an argument may be drawn in support of the foregoing views; for an electrified atmosphere has been found highly favourable to vegetation. The Abbe Bertholon has invented and employed an instrument calculated to draw down the electric fluid from a higher part of the atmosphere, and to disperse it through the air in a garden where plants are growing; and he speaks in the highest terms of the benefits of this "heavenly manure*."

The effect of thunder in destroying the living principle in eggs has been known since the days of Aristotle. He observes: "gallinâ incubante si tonet ova pereunt." This is a common remark among country people in the present day; and I am informed that it usually happens at the commencement of the incubation, consequently when the germ of life is just beginning to sprout. In what way is this to be accounted for, but by supposing that the deficiency of the vital principle in the air in some way produces a similar deficiency in the egg? It is well known that the blood of the ovum is aerated through the shell, and Mayow has supposed that a supply of *animal spirits, derived from the atmosphere,* was equally necessary to the perfect animal, the fœtus in utero, and the chick in the egg. And is not every opinion that has been entertained by such a man highly worthy of our attention?—a man whose sublime genius enabled him to penetrate through the darkness of the age in which he lived, and to make the principal of those chemical discoveries which it forms the

* Encyclopedia Britannica.

boast of the present age to have realized; though it was unequal to the more Herculean task of dispelling the clouds of ignorance and prejudice from the minds of his contemporaries.

Baron Humboldt and Mr. Todd have shown, that great debility and disease are produced in electric animals by the exertion of their peculiar powers in giving shocks. If then it is proved, as it appears to be the case, that they actually give out electric fluid in these operations, it will be evident that the abstraction of that principle is, in these instances, a cause of disease.

It is well known that the total abstraction of the principle of life from animal substances causes the putrefactive process instantly to commence. Does not the abstraction of electric fluid from them produce the same effect? Putrefaction instantly commences in animals killed by lightning, which is almost invariably electricity of the negative kind.

Mr. Wilkinson observes, that "frogs which have been long exposed to the operation of the galvanic conductor, more especially in water, suddenly fall into a corrupted state. 'How extraordinary will it be,' observes Mr. Valli, 'if hereafter it should be found that the electric fluid retards putrefaction, and resists the dissolution of bodies! Prior to the discovery of galvanism, it was known that *the fluid which circulates in the nerves is a powerful antiseptic*.*'"

Whence arises the putridity of portions of animal food, suffered to remain an hour or two between the teeth, but from the negative electricity of the air produced in respiration? Heat and moisture alone are entirely insufficient to account for it; for our food in India is very frequently exposed to these causes without the same effects. Is it not likewise found that animal substances rapidly run into putrefaction in the conditions of the atmosphere which are marked by deficiency of the electric fluid?

Mr. Webster remarks, that "from universal observation it appears, that during the state of the air which produces con-

* Elem. of Galvanism, vol. i, p. 40.

tagious diseases in unusual numbers, all kinds of flesh and vegetables are more apt to putrefy than in a healthy state of the atmosphere. This was observed by Diemerbrock, in the Holland plague of 1636, and we have had many proofs of it in America within a few years past *. And this is evidently true not only with regard to fresh animal meat, but also of salted meats of all kinds. The powers of salt appear to be insufficient to defend flesh and fish against the strong tendency to dissolution which seems to attend them in certain years. Hence we so frequently hear of spoiled beef and pork and fish during sickly periods. In some seasons it appears to be almost impossible to keep provisions destined for foreign market. * * * This accelerated dissolution of flesh is the *effect* of the common principle of disease, and in its turn becomes a *cause* of disease †." Dr. Lind has likewise strongly remarked on the tendency of animal food to putrefy in the unhealthy seasons of tropical climates.

Dr. Balfour infers, that "along with the full and change of the moon, there is constantly recurring some uncommon or adventitious state or quality of the air, which increases fever and disposes to an unfavourable termination or crisis; and that along with the intervals there is as constantly recurring a state or quality of the air opposite to the former; which does not excite, but diminishes fever, and disposes to a favourable termination." He likewise informs us that "it is a fact, established in this country on universal observation, that the tendency of meat to spoil is much greater at the full of the moon, than during the intervals." Analogous to these are the following observations of Mr. Webster: — "Popular opinion considers the moon as exerting a powerful influence on animal substances; and it is an incontrovertible fact, that its beams accelerate the putrefaction of flesh and fish. Fishermen and sailors can all attest the fact, and it coincides with what Pliny

* During the extensive prevalence of the yellow fever, which appeared in 1791.

† History of Epidemic Diseases, vol. ii, p. 197.

asserts. 'Id manifestum esse, quod ferarum occisa corpora in tabem viso suo resolvat." Moonlight dissolves or corrupts the flesh of animals that are killed, it renders sound fish soft in a few hours; and fishermen are careful to cover from its rays the fish they have caught."

The effects are here attributed to the moon's rays, but with little appearance of reason. They are known to consist of mere light, and it is perfectly incredible that they should have an effect which is not found to arise from the vastly greater degree of the same cause which exists during the day. The influence of the moon on the human frame has been likewise attributed by some to this cause. The inhabitants of Batavia are said to attribute their fever to the moon's beams; to dread them more than those of the sun itself, and to defend themselves from them by umbrellas *. But these suppositions are directly contradicted by the known fact of the moon's influence being as great at new as at full. I can assert from experience, arising from the habit of sleeping in the open air, that the strongest tropical moonlight has no injurious effects on the frame †.

It is a matter of common observation, that thunder produces the acetous fermentation in beer and milk; and Dr. Heyne, in the paper above quoted, asserts that the lunar influence has similar effects. If this is true, it strongly argues identity of cause. Mr. Webster observes, "that milk sours in a rainy day in summer without thunder, with the thermometer at 64°; as I know by observation. The barometer

* Dr. Heyne's MS on Hill Fever.

† An inhabitant of a temperate climate can form no idea of the luxury of sleeping under the canopy of heaven, in the hot weather in India. I have practised it for many years, not only with impunity, but with evident benefit; for the bracing coolness of the night air, and the sound sleep it produces, have counteracted the debilitating effects of the high temperature during the day. It is probable, however, that it requires a constitution fortified against disease by perfect temperance, to resist the sudden changes of temperature which frequently occur.

falls, vapour becomes visible; the functions of the body are languid; objects contract mould; in short, the atmosphere is inelastic, and ill fitted to maintain vigour in animal or vegetable bodies."

Mr. Wilkinson has been strongly impressed with the importance of the agency of atmospherical electricity on the human frame. He says: — "To the variations of this principle in the air, are to be ascribed the changes we undergo as to our sensations, together with the langour and indolence we experience, when the atmosphere is but feebly charged with electricity. So also, on the contrary, we may account for the cordial exhilaration we feel when the barometer is high, and consequently the air charged with electricity *.

He has also supposed, that the principal use of oxygen gas in respiration is to *supply the electric fluid to the blood*, during the change that the air undergoes in the lungs; an opinion which is strongly supported by the facts which shew that an extrication of electric fluid actually takes place in many instances from the combination of oxygen, previously in the state of gas, with combustible or oxidable substances. Thus the oxygen gas derived from the atmosphere gives out electric fluid during the combination of its base with zinc, in the galvanic process; and the same takes place on the rubber of the machine †. Dr. Bostock concludes that "the electric fluid is *always* liberated when an oxidable substance is united to oxygen ‡." It is very evident that carbon is united to oxygen in the process of respiration §.

* Elem. of Galvanism, vol. ii, p. 438.

† Ellis's "Farther Enquiries" concerning Respiration, &c.

‡ History and Present State of Galvanism, 1818.

§ Views similar to those of Mr. Wilkinson appear to have been entertained by Mr. Ellis; whose opinions on any subject, and particularly on this, must carry with them the greatest possible weight. He says: "But if, from the foregoing facts, it appears, that, in ordinary cases, oxygen gas is alike necessary to the development of caloric in combustion and to the excitation of electricity; if, in each instance, this gas

It may be conjectured, that large quantities of electric fluid are also continually carried off from our frames by evaporation. That process abstracts this principle together with the vaporized fluid; and in proportion to the quantity of evaporation, and the perfection of the change from the fluid to the aeriform

disappear, and its ponderable matter enter into a similar combination; and if no caloric or electricity be developed unless these chemical changes take place, are we not constrained to believe, that the same subtle matter, which, during combustion, is exhibited in the form of caloric, appears, during electrization, in the guise of the electric fluid? For why should oxygen gas be thus essential to the development of electricity, if it be not *chemically* instrumental in affording electric matter? and in what other way can it, in these experiments, be conceived to afford such matter, except by suffering that reduction of its elasticity, which it has been shown to undergo? If the air were only mechanically concerned, and acted simply as a *conducting* body, or if the electricity were excited only by friction, then no reason appears why oxygen gas should be thus essential to the operation, and much less why it should undergo such *chemical* changes; for that these changes are necessary, is proved by the fact, that even oxygen gas itself is unequal to the production of electricity, if a metallic substance, incapable of oxidation, be employed as an amalgam. Surely the conversion of zinc into an oxide by combustion in oxygen, does not furnish any other or better evidence of the extrication of caloric from that gas, than the formation of a similar oxide in electrization affords of the development of electric matter from the same gas, in the experiment of Dr. Wollaston. In both cases, the subtile matter is not simply *conducted* by the air, but is *generated* out of it; and, in both cases, therefore, its production must be the *consequence*, and not the *cause* of oxidation."—*Farther Enquiries*, p. 189. It is necessary to observe, that Mr. Ellis does not consider the agency of oxygen gas as the sole source of the electricity either of the machine or the galvanic pile.

At the conclusion of that work Mr. Ellis announces his intention of "attempting to trace all the observed effects, which succeed to the exercise of the respiratory function in plants and animals, to the *varied agency of that subtile or calorific matter*, which is universally liberated, by the changes induced on the air, during the continuance of this living process."

state, will probably be the quantity of electricity conveyed away. Large quantities of water are continually changing from the fluid state to that of perfectly transparent vapour, on the surface of the body, and flying off from it by the insensible perspiration.

As evaporation produces negative electricity, it may at first sight be conjectured, that that property, as observed in respired air, is owing to the evaporation which appears to take place from the surface of the lungs; but it is constantly found that the negative electricity arising from evaporation is met with in the vessels from whence the vapour arises, whilst the vapour itself by condensation produces positive electricity *. On the contrary, it is a much more reasonable subject of doubt, whether the moisture of respired air is owing to evaporation or to deficiency of electric fluid? The latter cause alone is sufficient to produce the effect, by weakening the attraction between the air and the water, which it *previously* held in perfect solution, as we see by the experiment of the air-pump. It is evident that water may exist in the air in large quantities, in such a state as to be hidden from our senses, as after long droughts; but when the bond of electricity is withdrawn, it becomes evident to them by moisture, or by visible vapour, and when the abstraction is more complete, by rain.

It may be found that rain does not invariably accompany the epidemic; but this will not be sufficient to condemn the theory of its cause which has been proposed; for it is evident that the quantity of rain must be in proportion, not only to the deficiency of electricity, but to the quantity of water in the atmosphere. Thus after heavy rains, when the atmosphere has parted with all its water, if the abstraction of electricity continues, the disease will continue, without rain. Other causes may prevent the rain, though much water is contained

* Encyc. Brit. art. *Electricity*.

in the air. Heat as well as electricity enables water to retain the aeriform state; and hence, probably, in very hot weather a deficiency of electric fluid may exist in the atmosphere without rain. I am confident, however, that the disease will scarcely ever be found to appear to any extent without either heavy clouds or rain.

It may be objected, that the atmospherical phenomena which have been observed in many instances to attend the epidemic have presented nothing unusual at the time — that they have often been only such as are constantly occurring in all countries without being attended by an epidemic cholera. If however we look at the general state of the weather during the years in which the disease has prevailed, we have the fullest evidence that a very unusual state of the atmosphere has been present. This appears to consist chiefly in a deficiency, either partial or general, or a destruction of the equilibrium of its electric fluid, existing in infinite variety of degree and situation. In those cases in which it is present in a small degree, it is probably insufficient to produce the disease, or to keep up its accompanying phenomena, until the new or full moon, or other common occurrences producing only common changes in the air, so far increase that state as to render it evident by its effects on the frame; in the same manner that the slightest cause produces disease in a body predisposed to it. But it is not necessary to suppose that the quantity of rain, &c. is in proportion to the quantity of *one* of their causes. Again, it may be urged that heavy rain is constantly occurring in India, unattended by cholera; and an argument so specious may appear conclusive to a superficial inquirer. Yet it is very easy to suppose a case, the probability of which cannot be denied, in which this must necessarily happen consistent with the theory. Rain and clouds form chiefly in the upper regions of the air, for it is there that vapours, from their less specific gravity, collect. It is constantly found that different strata or portions of the atmosphere are differently

charged with electricity; and if we suppose that a portion of the higher regions, loaded with moisture, becomes negatively electric, whilst the stratum near the earth is in the positive state, the effect will be heavy rain, accompanied by health. And if the case is reversed — the stratum contiguous to the earth only being in the negative state — the effect will be the disease without rain. It is probable that the last-mentioned circumstances have occurred in the Marquis of Hastings's camp, in November 1817; which is the only instance I have heard of, in which the disease is stated to have occurred without rain or thick clouds. In this instance very heavy dews and fogs in the morning are stated by Mr. Jameson to have occurred; which sufficiently show the disposition of the air near the surface to deposit its moisture. On this occasion, too, the most marked benefit was found to arise from a removal to a higher situation *.

* It appears from Mr. Jameson's work, that this attack commenced on the 6th, 7th, or 8th; the moon being at change and at perigee on the 9th. Her approach to the earth on this occasion, was likewise the greatest that she made during the year. It is mentioned that the disease began to abate on the 17th. The moon was at the quarter on the 16th. In a note at p. 8, Mr. Jameson mentions the periods at which nineteen different places in Bengal were first attacked by the disease in August, September, and October, 1817. Six of these appear to have happened about the first and last weeks of these months, but the precise dates are not mentioned. The remaining thirteen are stated to have occurred from the 15th to the 19th days. These circumstances appear to support the conjecture which I have hazarded regarding the influence of the new moon and perigee of those months. It is probable that they express rather the first appearance of the disease in an alarming form, than the time when it first showed itself — such, at least, appears to have been the case at Chuprah. If these attacks actually began two or three days earlier, they will all have happened a short time after the new and perigee. The occurrence of so many attacks about the same time of each month is, at least, very remarkable. In the appendix to Mr. J.'s work I find many instances of the attacks beginning at new and full; but those which I have before adduced are sufficient to

There is however one prerequisite which is necessarily supposed to attend the attacks of the epidemic, and if it is proved to be absent in a single instance of a general attack, the theory must fall to the ground; — that is, a deficiency of electricity in the air which is actually breathed. This can be clearly ascertained only from accurate experiments with electrometers, previous to and during the attacks.

In a preceding part of the work it was promised, that a state of the atmosphere unfavourable to respiration should be shown to accompany the epidemic. This I trust has been accomplished: and further, that the immediate effect of this state is probably to produce a deficiency of electric fluid in the blood. Little more of hypothesis, and that strongly supported on every side, will, therefore, be required to show the probable manner in which the state that has been inferred to be the proximate cause of the disease is produced.

It has been a common supposition, particularly in former times, that the brain is an organ of secretion, whose office it is to prepare and supply the nervous fluid. All the secretions are produced from the blood; and the nervous fluid has also been believed to be derived from thence. This fluid has been commonly looked upon as identical with the electric fluid. Hypothesis is of no value except in so far as it leads to accurate inquiry, and is supported by facts. If these opinions, and the others regarding the causes and pathology of cholera, which I have endeavoured to support, shall be found to be thus confirmed, they will explain in the simplest and most satisfactory manner the train of causes and effects which

prove the fact; and the subject has already been treated perhaps too diffusely, for its practical uses are not in proportion to its curiosity or interest.

begins in the atmospherical condition, and branches out into the numerous phenomena of cholera. The deficiency of electric fluid in the atmosphere produces a correspondent deficiency of that principle in the arterial blood; whence the nervous system is rendered incapable of separating and supplying a sufficient quantity of the "*neuro-electric fluid*" to the wants of the animal economy; and that state which has been termed "diminution of nervous energy," with its infinite series of effects, is produced.

CHAP. X.

BRIEF SKETCH OF THE TREATMENT OF CHOLERA.

THE first, and perhaps the most important object to be attended to in practice in this disease, is the *early* employment of our remedies. From the careless and sanguine temper of the soldier he will not usually, of his own accord, report his illness until it has made considerable progress; but he is, fortunately, perfectly amenable to authority, and therefore the great desideratum of early treatment will be gained, in the greatest part of our practice, very much in proportion to the exertions employed by the medical and other officers. If a steady and intelligent non-commissioned officer of each company be appointed during the prevalence of the disease, with orders to discover and report the first appearance of illness in the men; and if sentries at the privies receive orders to report any men who frequent them more than once or twice in twenty-four hours, and other equally obvious precautions are adopted, it can seldom happen that the most favourable moments for treatment—the first onset, however slight, of the disease—can be suffered to escape. I am likewise convinced that much mischief has arisen from a disposition to doubt the existence of the disease in patients who present themselves, until the whole train of its formidable symptoms are developed, and consequently until it has gained so much ground as to be combated at a great disadvantage. The first symptoms are, however, sufficiently well marked, and little less

certainly indicative of the disease than those which follow. We know too that all diseases tend to put on the form of an epidemic which is prevailing generally at the time of their occurrence; and we should seldom err in applying the treatment of this epidemic to many of the numerous slight affections of various kinds which occur at the same time, and, however different at first, are often seen quickly to assume the form of cholera. At least the mal-practice which might thus arise bears no comparison to that of the opposite system.

Sydenham has long ago maintained that opium is the sheet-anchor in the cure of cholera. Such it has been in the treatment of this epidemic; and it has proved itself worthy of the character. It is probable that a single dose of it alone, given at the very commencement of the disease, would be found in a great majority of instances to put an effectual check to its progress. Valuable as this medicine is, there is not, however, a more pernicious error into which we could fall than its abuse. In its secondary effects, and perhaps in the immediate effects of very large doses, it produces all that oppression or abolition of the powers of life which so strongly mark the greater degrees of the disease. If, then, we proportion the quantity of the remedy or its repetitions to the danger, we shall probably produce or increase the very affections which we attempt to obviate or remove. Solid opium in the form of a soft bolus appears to be preferable to the tincture; it is less liable to be rejected, not only from its more gradual diffusion over the stomach, but from the mechanical obstacle which that state offers to its expulsion. It almost constantly happens that a pill or bolus are retained, though the fluid contents of the stomach are immediately thrown out. Besides, when rejected the fact is easily ascertained. Four grains appear to be about the proper quantity to be given at first to an adult*. This may appear too large a dose to persons

* Indian opium, which is here alluded to, is considerably weaker than that of Turkey. Three grains of the latter may be equal to four of the former.

unacquainted with the decisive practice to which the urgent nature of this epidemic has led; but experience warrants the use of that quantity. It is advisable to begin with a full dose at a period of the disease when it is most assailable, when the remedy is most indicated, and least forbidden by the symptoms. If favourable symptoms do not appear, the dose may be repeated, but in diminished quantity, at intervals of three, four, or six hours, with the view of keeping up the primary or favourable effects of the remedy, and preventing that sinking which appears to *follow* its use. In the last stages, however, its effects appear to be almost uniformly injurious. It is not then indicated by any one symptom except the anxiety and want of natural sleep; and experience has shown that no quantity of the remedy is sufficient to remove these symptoms, under those circumstances. It must also increase the stupor, and probably the inflammation, which are then present. It is evident that the first dose of this invaluable medicine is that on which our chief dependence is to be placed; and in cases where the disease has made some progress previous to admission, or where the symptoms are very alarming, a quantity somewhat larger than that above mentioned may be ventured upon. And in very urgent cases, where the solution of a pill in the stomach would be too slow, it may be given in a liquid state. Injection, or the introduction of solid opium into the rectum, are likewise valuable methods of employing this remedy.

It has been the general practice to combine the opium with scruple doses of calomel (a mode of treatment for which we are indebted to Dr. Johnson), and the best effects have been stated by many practitioners to result from that measure. It must however be observed, that the benefits of this practice have been by others strongly called in question. A practitioner for whose opinion I have the highest deference, and whose practice in the disease appears to have been more successful than any other which has come to my notice, has never given the calomel until after the favourable crisis.

Stimulants, as brandy, aromatic tinctures, camphor, and essential oils, are strongly indicated in this disease; and there cannot be a doubt of their good effects, when judiciously employed, and in moderate quantities. A sufficient dose of these remedies is highly useful and necessary in combination with the first dose of opium; and a repetition of them in frequent *small* quantities during the continuance of the dangerous symptoms, unless counter-indicated by the preponderance of the inflammatory affections, heat of skin, &c., and the less urgency of the debility, is not less obviously beneficial. In the use of these medicines, as well as of opium, the principal danger appears to be that of *doing too much*. A strong tincture of cloves in brandy was the principal of the remedies of this class which I have employed.

Bleeding has been extensively practised in this disease on all the three establishments, and has received the highest encomiums. There is, however, reason to believe that the opinions of medical men are still divided as to its general propriety. My own experience and inquiries have been such as at once to impress me with a high opinion of its good effects, and to show the necessity of caution and discrimination in its employment; for though its effects have been in general favourable, in some instances they have appeared the contrary. It is scarcely necessary to point out the habits in which this remedy is most applicable; the young, the robust, and plethoric, and particularly the European. It is a measure which is not necessary, and may do harm, in the slighter cases; and though its benefits are doubtless greatest when employed early, yet the lesser evil appears to be to defer it until symptoms arise indicating considerable danger, when it is not called for by symptoms clearly showing its necessity. In those cases which are marked by highly increased action, it is our most valuable means of preventing the occurrence of the opposite and more dangerous state, and of those highly dangerous visceral inflammations, which in many instances would certainly follow in the European habit, without its use,

and often of removing those latter affections when set in. In the latter stages, and in most lingering cases, this remedy, as well as almost every other, is found perfectly inadequate to the removal of the active inflammation which so frequently then prevails. From some accounts of the effects of bleeding in this disease, we might be led to expect the pulse to rise under the operation; but this, I believe, will rarely occur. In my experience, the first effects of the evacuation have been, in this as well as other diseases, a diminution of the force of the circulation; but the vessels, relieved of a load which the disease had rendered them unequal to, quickly regain their tone and act more vigorously than before. In some instances, however, the pulse has sunk immediately after the bleeding, and never risen again; but in all probability this would have happened in a short time without the operation. Much still remains for future observation to determine regarding the limitations which are necessary in the use of this remedy*. The operation should invariably be performed in the recumbent posture, and care taken to prevent the patient rising after it; as it is obvious those precautions must lessen the danger of producing that sinking which so often follows the remedy. In fact, it is advisable to preserve that posture throughout the disease, for the others are often found in an instant to bring on returns of the vomiting and spasms.

The various means of exciting counter-irritation on the

* In justice to Dr. Johnson it is necessary to mention, that his valuable work on Tropical Diseases (which is in the hands of almost every practitioner in India) appears to have led to the adoption of bleeding in this epidemic. And the merit which accrues to him from this suggestion is of no common kind; for, according to the unfortunate notions which have so long prevailed, it is probable that few persons would have ventured on a practice of this kind, in a disease whose principal characteristic is extreme debility, without some previous evidence of its propriety.

surface of the body are among the most valuable and least objectionable of our remedies in cholera. Experience seems to have uniformly declared in their favour. In a disease so rapid that it frequently gets beyond the power of art in a shorter time from its commencement than a blister requires to produce its effects, it is evidently desirable that these effects should be gained as quickly as possible. Various means have been employed with this view, as the hot-water blister, nitric acid, moxa, &c.; but it is doubtful whether a *rapid* effect is not more desirable than an *instantaneous* one; and the extreme pain and annoyance which these remedies produce appear to be a great objection to their use. Sinapisms have the advantage of acting rapidly, but they are excessively painful and distressing. They have however been highly recommended. In some instances I have rubbed the part intended to be blistered strongly with oil of turpentine and sand, previous to applying the blister, and have found such a degree of inflammation immediately produced, that the blister has had its full effect, even on the scalp, in two or three hours. The parts most proper for these applications appear to be the stomach, abdomen, and head; and there cannot be a doubt of the propriety of their early employment.

A very simple and elegant method has been suggested of applying heat and aqueous vapour to the surface of the body, by burning spirits under the patient as he lies on his cot. This ingenious invention has generally superseded the use of the warm bath; which is very troublesome in its preparation and annoying to the patient. It appears also to possess additional virtues; for it is said to have been found highly beneficial, even in some of those low cases where almost all other remedies seem to be either useless or injurious. And in the more manageable cases, its good effects are said to be very striking. A strong objection has however been made to it, which certainly seems to forbid its use; its vitiating the air which the patient breathes, and thus increasing the

want of aeration of the blood. The warm bath in a reclining posture will probably be still found one of the best means of restoring heat, and exciting and determining to the surface. Stimulating frictions of capsicum, &c., have also been extensively employed.

Draughts of any liquid have frequently been found to bring on returns of the vomiting; but the thirst is so excessive, that it would not only be a great cruelty, but a practice of very doubtful tendency wholly to refuse to gratify it. I have constantly allowed moderate quantities of an infusion of fresh or dry ginger; which, with the addition of sugar and a little milk, forms a beverage very agreeable both to the palate and stomach, and is at the same time a gentle stimulant and a light kind of food.

After the favourable crisis, *purgatives* are chiefly to be depended on for preventing or removing that numerous train of fatal sequelæ which so frequently attend the disease. They are found to produce copious discharges of vitiated bile and feces; and, however we may reason upon the manner in which this evacuation produces its good effects, we cannot doubt its propriety. Calomel, from its known powers in this way, is highly useful; but it appears advisable, in general, to avoid its full effect on the mouth. Great irritability of the stomach, probably from remaining inflammation, will often be present in this stage; and it will, of course, be necessary to choose those purgatives which sit most easily on the stomach. This advantage will be found to arise in a considerable degree from combining them with bitters, which will probably tend also to restore the lost tone of the intestinal canal.

The great debility which necessarily follows, for a short time, a severe attack of cholera, might lead to the employment of stimulants, and a "nourishing" diet; but such practice appears highly reprehensible. Simple debility is not what we have chiefly to dread in this, or perhaps in any other disease; nor, if it were, is this the means, in general, most likely permanently to remove it. On the contrary, a strict

antiphlogistic regimen is commonly necessary to prevent the setting in of highly dangerous inflammation. The food should be simple, chiefly vegetable, and in small quantities at a time; and, if any stimulating liquors are ever allowed, their quantity should be very small.

Among the prophylactic measures, the advantage of high, dry, and airy situations stands pre-eminent. The removal of troops, when attacked by the epidemic, to such places, is a means which is almost always in the power of higher authorities to employ; and it promises to save more lives than all the curative efforts of art.

SUPPLEMENT

TO

THE SECOND EDITION.

[In the following continuation of the enquiry into the remote causes of the epidemic,—or rather its causes, for the proximate cause is the disease itself,—I have endeavoured to compress the principal part of the information which the present state of our knowledge of the subject seems to afford, into a series of inferences or propositions; which, as they are presented to the reader, will be followed by a statement of some of the clearest of the facts from whence they are drawn, together with such observations and farther details as may arise on each occasion.]

SECTION I.

OF THE CONTAGIOUS NATURE OF THE DISEASE.

PROPOSITION I. The disease is contagious; that is, it is conveyed either mediately or immediately from person to person.

II. There is reason to believe that the virus which propagates the disease is of a very subtile or volatile nature, and is readily conveyed by the atmosphere; whence it arises that there is little if any increase of danger from the most intimate communication with the sick during the prevalence of the disease, above that which attends the common intercourse of society.

III. The latent period of the disease, or that which elapses between the application of contagion and the appearance of symptoms, is usually very short, and even sometimes imperceptible, but on some occasions it has been more protracted.

The doctrine of contagion in general has gained very little support in India. It is scarcely ever entertained by the natives, except in the obvious cases of small-pox, &c. The few acute diseases usually prevalent in that country (for malaria fevers and inflammations of the liver and large intestines form nearly the whole list) are all either decidedly not contagious, or at least never considered so. The idea of that influence therefore very seldom entered the mind of the Euro-

pean practitioner in India prior to the rise of this epidemic. The opinion had never before been publicly broached, either there or in Europe, that cholera was contagious; for its nervous nature seemed to preclude the possibility of such a quality, as much as in epilepsy or hysteria. It was therefore not without astonishment that many of the profession in India heard that the Medical Board of Bombay, in 1818, held the disease to be contagious. My feeble voice, in common with the great majority, was raised in opposition to the—as it appeared—monstrous dogma; but the march of time and events, the great accumulation of facts and gradual removal of prejudices, have wrought in my mind the same revolution that they have in so many others. The opinion of the contagious nature of the disease has been gradually gaining ground even in India, and seems to be the general one of Europe. *Veritas magna est et prævalebit.*

It is not however without an attentive examination and generalization of the numerous facts that appear on this part of the subject, that a reflecting person is able to come to any satisfactory conclusion regarding it; for unfortunately for the cause of science, the mass of evidence which it exhibits is of the most conflicting nature, and at first sight appears totally irreconcileable. I must therefore crave the patience of my reader whilst I detail, in as few words as possible, the principal part of the facts which have been observed or recorded (chiefly in India) bearing on both sides of the question.

And first, with regard to the general voice of the medical world and people at large in India. Mr. Jameson declares, in 1820, that in Bengal it was uniformly against the opinion of the disease being conveyed from person to person; that the natives never entertained that idea; and that the whole list, of at least two hundred and fifty European medical officers, were, with one exception, unanimous on the subject. On the Madras establishment also, the majority of the medical officers are adverse to the opinion of contagion; but there are many, and among them Mr. Scot, the ingenious author

of the highly valuable report of the Madras Medical Board, who produce the strongest facts in its favour. The doctrine has also been warmly advocated by many persons on the Bombay side of India.

The natives of India are a very unenlightened and prejudiced race. Some idea of the value of their opinion on any doubtful subject may be formed from the fact of their universally believing that the malaria fevers are owing to drinking bad water. But in some instances it is stated that they had discovered the cholera to be contagious. Mr. Chapman, at p. 189 of the work just mentioned, states that they commonly avoid their sick as much as possible, and desert infected villages. The staff-surgeon of Travancore (where the disease is endemic) relates that in a former epidemic visitation of it in that province, the native physicians deserted their charges from fear of contagion, observing that so many died in one family. And the British resident of Travancore, on the occasion of the present epidemic, formed a *cordon sanitaire* round that province, restricting communication, but without success. It appears farther, that separation and quarantine had been extensively practised in one of the divisions of the Bengal army, and it is stated, that they had been found very useful. Moreover, although the general doctrine of the conveyance of the disease from person to person was so uniformly denied by the Bengal medical officers, it was considered probable by many of them, that a *large body* of infected persons might carry about the disease and transfer it to healthy persons;—an immense concession, which Mr. Jameson himself seems fully to make*.

The evidence of the anti-contagionists is necessarily of the negative kind. One of the strongest general facts which they produce is, that the numerous medical and inferior attendants on the sick in the hospitals have often entirely escaped, or suffered in a very trifling degree from the disease;

* Bengal Report, p. 144.

and it must be admitted, that in a vast number of instances in India, those persons have suffered no more from their employment than if they had been attending so many wounded men. This is a fact, which, however embarrassing it may be to the medical inquirer, is highly consolatory in a practical point of view, both to him and to all whose close intercourse with the sick is imperatively required.

In Bengal, not more than three medical officers out of the whole list were known to have been attacked up to 1820, and but one died, though nearly the whole of them had largely witnessed the disease. This is a strong fact, which probably will have greater weight than Mr. Jameson's general assertions to the same effect:—that the medical observer in Bengal did not find his assistants or sick attendants more liable to be attacked with the disease than other persons; nor when one member of a family was ill, that the rest were more liable than others; and that when several of a family were attacked, it was in general simultaneously and not in succession. It is however more particularly stated, that in the Marquis of Hastings's camp, where the disease prevailed so severely, in no instance were the bearers of the sick—nor the immense number of hospital attendants—nor soldiers visiting their dying comrades—nor sick in hospital (with the exception of convalescents), attacked more frequently than other persons not thus exposed*.

* Report, p. 131.—The graphic picture which Mr. Jameson has drawn of the prevalence of the disease on this occasion is so strikingly illustrative of these awful visitations, that I cannot resist the temptation of presenting it to the reader, particularly as the work in which it appears is not accessible to the public.

"It was here that the disease put forth all its strength, and assumed its most deadly appalling form. It is uncertain, whether it made its first approaches on the 6th, the 7th, or the 8th of the month. After creeping about however in its wonted insidious manner for several days among the lower classes of the camp followers, it as it were in an instant gained fresh vigour, and at once burst forth with irresistible violence in every direction. Unsubjected to the laws of con-

Similar facts have been largely observed by highly credible persons on the Madras establishment:—Mr. Gibson at page 1, of the Madras Report; Mr. Haines, at p. 32; Mr. M'An-

tact and proximity of situation, which had been observed to mark and retard the course of other pestilences, it surpassed the plague in the width of its range, and outstripped the most fatal diseases hitherto known, in the destructive rapidity of its progress. Previously to the 14th, it had overspread every part of the camp; sparing neither sex nor age in the undistinguishing virulence of its attacks. The old and the young, the European and the native, fighting men and camp followers, were alike subject to its visits, and all equally sunk in a few hours under its most powerful grasp. From the 14th to the 20th or 22d, the mortality had become so general as to depress the stoutest spirits. The sick were already so numerous, and still pouring in so quickly from every quarter, that the medical men, although night and day at their posts, were no longer able to administer to their necessities. The whole camp then put on the appearance of a hospital. The noise and bustle almost inseparable from the intercourse of large bodies of people had nearly subsided. Nothing was to be seen, but individuals anxiously hurrying from one division of the camp to another, to inquire after the fate of their dead or dying companions; and melancholy groups of natives bearing the biers of their departed relatives to the river. At length even this consolation was denied to them, for the mortality latterly became so great, that there was neither time nor hands to carry off the bodies, which were then thrown into the neighbouring ravines, or hastily committed to the earth on the spot in which they had expired, and even round the walls of the officers' tents. All business had given way to solicitude for the suffering. Not a smile could be discerned, nor a sound heard, except the groans of the dying and the wailings over the dead. Throughout the night especially, a gloomy silence, interrupted only by the well-known dreadful sounds of poor wretches labouring under the disgusting symptoms of the disease, universally prevailed. Many of the sick died before reaching the hospitals, and even their comrades, whilst bearing them from the outposts to medical aid, sunk themselves, suddenly seized by the disorder. Never was the impressive language of Scripture more applicable than now, 'In the midst of life we are in death!' All security of life was gone, and as youth and vigour afforded no safety, even the healthiest man could not in the morning tell that he might not be a corpse before night. Such was the dreadful effect of the scene, that even long

drew, at p. 33; Mr. Smith, p. 38; Mr. Sutton, p. 41—45; Dr. Scott, p. 57; Mr. Campbell, p. 77; Mr. Mitchell and Mr. Chalmers, p. 141; Dr. Fasken, p. 201; all state, that after its occurrence it could hardly be described without shuddering by eye-witnesses.

"The natives, thinking that their only safety lay in flight, had now begun to desert in great numbers; and the highways and fields for many miles round were strewed with the bodies of those who had left the camp with the disease upon them, and speedily sunk under its exhausting effects. It was clear, that such a frightful state of things could not last long; and that unless some immediate check were given to the disorder, it must soon depopulate the camp. It was, therefore, wisely determined by the commander in chief, to move in search of a healthier soil and of purer air. The division accordingly on the 13th marched in a south-easterly direction towards Talgong and Sileia; and after several intermediate halts, on the 19th crossed the clear stream of the Betwah, and upon its high and dry banks at Erich, soon got rid of the pestilence, and met with returning health. But its line of march, during the whole progressive movement, exhibited a most deplorable spectacle. Although every means had been taken, by giving up the ammunition carts, and collecting elephants and draught cattle, to procure sufficient carriage, the sick were found too numerous to be moved, and were in part necessarily left behind. And as many who left the carts, pressed by the sudden calls of the disease, were unable to rise again, and hundreds dropt down during every subsequent day's advance, and covered the roads with dead and dying; the ground of encampment and line of march presented the appearance of a field of battle, and of the track of an army retreating under every circumstance of discomfiture and distress. The exact amount of mortality during these few calamitous days could not, from the circumstances of confusion and general disorder under which it took place, be ascertained with any degree of accuracy. From the military returns however it appears, that in this fatal week, of 11,500 fighting men of all descriptions, 764 fell victims to the disorder; and of the camp followers, it was conjectured, that about 8,000, or one-tenth of the whole, was cut off. The disorder ceased to be epidemic about the 22d or 23d. A few instances of mild attacks were after that seen daily till the end of the month. After the 8th of December not a case appeared." It is added, that 3,000 of the troops left camp before the disease appeared, or early in its progress, therefore the comparative mortality is much increased.

their numerous attendants, and many of them also their sick in hospital of other diseases, though mixed with the cholera cases, either entirely escaped, or suffered but in a very moderate degree. And be it remembered, they were constantly employed in rubbing the patients for the removal of the spasms, placing them on the stools, in the baths, &c.

Dr. Goldie, superintending surgeon, makes a similar statement with regard to his own station and four others, the principal ones in the southern division. Some of them also state that the disease did not appear to run in families. Mr. Annesly, who long had charge of the general hospital at Madras, in his treatise on the disease, states: "I never saw more altogether than five or six persons, whilst patients in the hospital, attacked with the epidemic cholera; and although I have had thirty or forty cases of this disease in the hospital at one time, when it contained not fewer than from one hundred to two hundred and seventy patients, yet not one instance of cholera occurred which could be imputed to the admission of these cases*."

Numerous instances are also adduced, where the disease prevails severely in one corps or body of people, and but slightly or not at all in another body, in close contact and intercourse with them. It is also urged that the disease first appeared among the prisoners in the fort of Masulipatam, and was for some time confined to them, though it might have been expected, if the disease was contagious, that it would rather have broken out in the surrounding city and suburbs, which held free communication with the country. And when it did appear elsewhere, it was not in the neighbourhood of the jail.

These facts appear so clear and strong, that if we looked no farther they would seem to set the matter at rest; but with regard to the general question of the contagious, or (if another term must be used) infectious nature of the disease,

* Madras Report, p. 214.

they appear to me as no more than dust in the balance against those which may be opposed to them.

In Bengal, as we shall subsequently see, the disease had always been endemic in some degree in various parts of the country; it had therefore many great local sources, whence its epidemic prevalence was, at least, greatly favoured in certain tracts; and, consequently, its progress over the country was exceedingly irregular, and probably its connection with contagion less marked than on the peninsula; yet many facts have forced themselves on the observers in that country, anti-contagionists as they were, which appeared to show that the disease was thus propagated. They relate, that a large party of troops marched from Meerut in Upper Bengal, and six days after passed through Delhi, where they first met with the epidemic, and encamped for a day a mile beyond that city. Two days after, pursuing their route, the disease broke out in them, and continued to prevail severely, though it did not exist in the villages on their road. In six days more they joined a large camp in health, except that it was said by some that one or two cases of cholera had appeared in it some days before; but on the day of the arrival of the party, it decidedly broke out, and prevailed for some time in camp before it reached the inhabitants of the place. The whole medical staff of the force expressed their conviction that it had actually been conveyed to them by the party*. The surgeon of the 14th regiment expresses his belief that the disease was contagious, observing persons about the sick particularly attacked†. Mr. Jameson also relates several instances of troops being immediately attacked on entering places where the disease prevailed. He also relates another occurrence strongly in favour of contagion. During a second and slight attack of Lord Hastings's force, " a sepoy died of the pestilence. Five of the corps, who had shown no signs of illness, were employed to carry the body to the grave.

* Bengal Report, p. 29. † Ibid. p. 316.

They were all seized with the disorder during the ensuing night, and all died*."

But it was on the peninsula that the most marked instances of the conveyance of the disease from place to place by contagion have been observed. They are too numerous to be all noticed. Previous to the appearance of the disease at Jaulna, in July, 1818, the troops at that station heard of an infected party being on the march towards them from Nagpour, and apprehended receiving the disease from them. Just so it happened. Four or five days after the arrival of the party the disease broke out among the camp followers at the station; the two first cases appearing in the same house, and others in its neighbourhood, and afterwards it spread from thence as from a focus through the place†." At this time another body of people arrived at the station in health. They halted two days, and after two more marches were attacked. They arrived shortly afterwards at a healthy station (Aurungabad), where also the disease broke out shortly after their arrival. From Jaulna too the disease is traced to Mulligaum, one hundred miles to the north-west; some camp followers dying on the road from the former to the latter place, and others being the first who suffered there, on their arrival‡. Again, that station is revisited in 1821, shortly after the arrival of a corps which had suffered from it on its march for a month before§. At Gooty the disease appeared in a very trifling degree on its first attack; and in February, 1819, they had

* Madras Report, p. 130. † Ibid. p. 70.

‡ It will be evident from inspection of the map, that the disease has appeared to proceed northward from Jaulna to Mulligaum and Nusserabad, contrary to its usual course, which is accounted for by these stations being dependent on Jaulna (the head quarters of the district), and consequently holding great intercourse with it; whilst they received it not in the direct course from Mow and other places about the Nerbudda, at no great distance to the north, with which they had no such communication, though it had prevailed in them for two or three months before.

§ Ibid. p. 19, 79.

had no case of it there for six months, when a very severe visitation began four days after the arrival of a corps (the 16th regiment), which had been affected with it on its march for twelve days before. The form of the disease which prevailed in the corps was an unusually low and malignant one, and the same type was transferred to the stationary troops and inhabitants. In about a month it spread over the neighbouring country*. Again, in 1821, the collector of revenue of this district (a high civil officer) writes: "Cholera first made its appearance in the neighbourhood of Gooty, where the 2d battalion 1st regiment N. I., which had suffered severely from the disease, halted for some time; it subsequently appeared in nearly every village on the route of the 15th regiment N. I., which was also severely attacked by the cholera as it passed through this district, and which halted at this station till the disease disappeared: in some of the larger villages, such as Dhurmaveram, it has carried off nearly two hundred souls. Doubts may be entertained of the contagious nature of the disease, but it appears to me quite certain, that the infection has been communicated or created here by the two regiments before noticed; the disease was unknown here until they arrived; it broke out where the first diseased corps halted for some days, and at nearly every village where the other stopped; it has been unknown in any other part of the district; and although it was unknown both in the 15th N. I. and the villages through which it passed, until they arrived in this district, it no sooner broke out among that body of men on march, than it communicated itself to the fixed residents who were before exempt from it."

At Hydrabad the disease is stated by the staff surgeon there to have appeared at the British Residency and an adjoining suburb of the city; that for some days it prevailed there before it crossed the Moussa into the city, and it did not reach the cantonments (Secunderabad, five miles to the

* Madras Reports, p. 9, 129.

eastward of the great road) for many days after its appearance at the Residency; that the first cases in the cantonment were in sepoys who had returned from duty at the Residency, and that the disease attacked the corps in succession from left to right of the line. And in the following year, the same officer reports, that a party had arrived there suffering from the cholera, which had attacked them on their march after exposure to *a heavy storm of wind and rain* on the Kistna, and destroyed about sixty of them before their arrival. The disease did not then exist in the station; but three or four days after the infected party arrived, it appeared in a detachment of artillery in barracks, two hundred yards in front of which the party was encamped. It spread to the native inhabitants and other troops, excepting the 30th regiment, which was in barracks at the distance of a mile; they entirely escaped. He also traces several cases in succession to close personal intercourse, and finds a medical officer and two dispensers of medicine attacked. He adds, that a medical officer, arriving a fortnight afterwards, reported that the villages on the route from the Kistna were all suffering from the cholera, and that the inhabitants had stated to him that they had got it from that detachment *.

The medical officer at Cuddapa reports in June 1821, that no case of cholera had occurred there for three months; that a corps suffering from the disease on its march halted there two days; and five days after its departure, the disease appeared in another corps at the station, and very soon after in the inhabitants †.

The origin and diffusion of the disease at Trichinopoly are very remarkable. The first case occurred in a sepoy belonging to a company arriving from Madras, which had lost several men of cholera on the road, and this man was ill when he arrived. He soon died, and a day or two after, a sepoy of the garrison was attacked, after which it appeared

* Madras Reports, p. 127. † Ibid. p. 221.

among the camp-followers (washermen, &c.) near him, and extended from the north-west to the south-east of the port, attacking one barrack in its course on the 9th November, another on the 13th, and a third on the 16th *.

In various instances it is reported, that the villages on a road have began to suffer immediately after the passage of an infected body of troops.

The 6th cavalry, coming from a country where cholera did not exist, and itself free from it, arrives at a place where it prevailed. A squadron of the corps is sent into an old pagoda in the village, whilst the rest encamps outside. The disease breaks out in the corps at that place, and that squadron furnishes almost every case in it†.

Mr. Chapman met with a solitary case of cholera in his corps, and on visiting it he felt a little nausea, which he attributed at the time to the smell of the evacuations, but it was followed next morning by a violent attack of the disease. He also relates several other cases, which appeared to have arisen immediately from personal intercourse.

In the Medical Repository for May 1826, Mr. Montgomery traces the rise of the disease in a body of people with uncommon distinctness. "A convict was sent from a village where cholera prevailed, to Chanda, eighty miles off. Two hours after his arrival he was attacked, and shortly died. Three of the four persons who carried him to the grave, and another who attended them, were the next sufferers, and shortly the disease became general.

Mr. Scot also traces the introduction of the disease into the Mount, a station near Madras, to a soldier arriving there from Madras, who is first attacked, and the next three cases happen in the same house. He also states various other facts and arguments on the same side of the question, to which he greatly leans, though he does not venture to decide on the subject; we find also, in the course of these reports,

* Madras Reports, p. 137. † Ibid. p. 48.

many other statements of similar tendency; and in particular we find various accounts, perfectly contradictory of so many others, that the medical officers and hospital attendants and sick in hospitals actually did suffer remarkably, and that the disorder was found to run in families. But these statements are neither so many, so precise, nor so strong as those of the opposite character *; and their force is greatly weakened by the consideration, that persons occupied about the sick, whether regular attendants or friends and relatives, must have suffered excessive fatigue and anxiety, which are powerful exciting causes of the disease. The medical officers of the Madras Establishment certainly have suffered from it in a greater proportion than other officers; thirteen of them having died of it in 1818 and the four succeeding years; and several strong statements appear regarding its running in families; but there is an almost entire want of evidence

* The amount of the evidence on these particular points may be briefly stated. Mr. Kellie had three sick in hospital attacked, and two of them were on the beds next to the cholera ward. Orderly sepoys, &c. were so often attacked, that their attendance was with difficulty enforced. When it appeared in a family, generally several were attacked with it. Mr. Train observed great numbers of men who had been attending their sick friends were attacked. Generally when one person in a family was attacked, others almost immediately followed, in some instances running progressively through the whole or nearly the whole family. Several orderlies were attacked. Mr. Barton had seen a family of eight all attacked, and six of them died, but himself and attendants did not suffer. Dr. Daun and the two assistant surgeons of his corps were all attacked; as were two other officers who attended on them, but no other officers at that station; several other persons about the hospital were also attacked. Mr. Provan observes, that several persons who had attended the sick had suffered, and there was some reason to believe that the effluvia from the dead bodies had produced it in others. A very strong and unqualified statement is, however, made by Dr. Burrel, on this side of the question, at p. 9 of the Bombay Reports; — that almost all the attendants in the hospital of the 65th regiment, thirty in number, had been attacked, in the first prevalence of the disease at Seroor.

to set against that of the opposite kind, of the numerous native sick attendants having suffered more than the rest of the community;—and very numerous they are in India, where labour is so easily procurable, that scarcely a private soldier is without a native attendant of some description. It has been said that the general immunity of hospital servants in India is owing to their being inured to the effluvia from sick persons; and similar experience in the plague is quoted in support of the position; but let us not attempt to prop up, and thus virtually weaken a good cause by bad arguments. They could not have been inured to the virus of cholera, for it did not before exist; nor have we, generally speaking, any other prevalent contagious disease in India. Besides, great numbers of fresh persons were hired into the hospitals on the breaking out of cholera. We are therefore forced to the conclusion, however at variance with the common laws of contagion, that in this disease—at least in India—the most intimate intercourse with the sick is not in general productive of more infection than the average quantity throughout the community.

This conclusion is further strengthened by another hiatus in the evidence for contagion, *viz.* that though the importation of disease has so often been found immediately to precede its appearance in the inhabitants of a place, and even the first cases to arise in the neighbourhood of the imported virus, it has scarcely ever been possible to trace these cases to personal communication in any thing like a regular series, as may generally be done with the plague and other decidedly contagious disorders; and similar facts have been observed in much later stages of the progress of the epidemic. Since its entrance into Russia, it has more than maintained the contagious character which it exhibited in India. In numerous well-attested instances, the appearance of the disease in places previously healthy has been immediately preceded by the arrival of persons from infected places, and such persons have been the first to suffer. But here, as in

India, it seems to have happened, that no sooner was the disease thus conveyed into a place, and perhaps a case or two seen in the new-comers, or near them, than the thread of its course through the rest of the community was lost:—its progression from its origin till it gained head could not be traced. The deficiency of evidence on this particular point has been strongly adverted to in a valuable critique on the subject, which has appeared in the 108th number of the Edinburgh Medical Journal. It contains also a particular statement of the staff physician at Orenburg, showing, that, there at least, the disease had also exhibited that other marked anomaly which has been noticed, of the immunity of attendants on the sick. Dr. Smirnov states that his hospital attendants, twenty-seven in number, during the two months the disease prevailed there, when two hundred and ninety-nine patients were treated in hospital, entirely escaped attacks, although they were constantly employed in offices which brought them into the closest contact with the sick. So also the physicians in continual attendance, and various other officers of the hospitals, and even the washerwomen, all escaped.

The obvious inference from all these facts, and which can alone reconcile their contradictions, is, that the morbific virus is of a most subtile and active nature, so that the atmosphere around the sick is quickly contaminated by it to a considerable distance, whence all who breathe such infected portions of the medium are equally liable to its influence; and when it prevails generally throughout a city, the whole surrounding mass, though not equally, is sufficiently poisoned to produce the full effect of contagion. From this *mobility* of the virus, and from the disease almost immediately following its application, it is enabled to spread with a rapidity, which, excepting in the instances of the sweating sickness and influenza, appears to be unparalleled in the history of epidemics; and everywhere to strike its invisible but deathly blow where it is not warded off by insusceptibility: whilst in the great mass of people, who happily are thus guarded, probably the morbid

secretions may be rubbed into the mouths of the absorbent vessels on the surface — or the effluvia arising from them inhaled into the lungs — or they may be taken into the stomach, or even inserted into the opened veins, without adding to the danger.

We have little evidence of the distance to which the morbid effluvia may be conveyed by the atmosphere without losing their effect; but some facts, as far as they are to be depended on, seem to show that it may be very considerable. Of two vessels arriving and remaining at anchor in Madras roads, one was attacked with the epidemic ten days after arrival there, and the other remained free from it for a fortnight longer; but on the first, in which it was still prevailing, changing her *berth*, and taking up a situation a quarter of a mile to windward of the healthy vessel, it was immediately attacked; and those who slept on the side next the infected ship suffered particularly *.

It is known that vessels arriving in India have never got the epidemic until they reached land; but Mr. Jameson states, that they have been known to have the disease break out in them as they ascended the Hoogly, before they had any communication with the shore. Mr. Cormick relates, that when the disease was raging in Tabreez in Persia, a large body of troops passed the city. "They were prevented by guards stationed at the gates from entering it, but several of them passed the day under the walls. During the following day, however, the disease manifested itself among them, and they suffered from it very severely †.

The whole history of the extension of the epidemic, in the course of a few years, over one-half of the more populous and habitable portions of the globe, strongly indicates its propagation by contagion, and is incapable of explanation on any other principles with which we have any acquaintance;

* Madras Reports, p. 25.

† Med. Chir. Transactions, vol. xii, p. 359.

for in all its long and various courses it may be traced from place to place; and has never, as far as our information extends, started up at distant periods of time and space, leaving any considerable intervening tracts of country untouched. It may be useful here to present a brief sketch of its origin and diffusion.

All attempts to trace the epidemic to its origin at a point appear to have failed, and to have shown that it had not one, but various local sources in the level and alluvial, the marshy and jungly tract of country which forms the Delta of the Ganges, and extends from thence to the Burrampooter. For here we find it as early as June, and the beginning of July, 1817, noticed as prevailing to a serious extent in Nuddea, a province which is stated to be notorious for the disease in its endemic form, and in Dacca, and at the same time it is distinctly exhibiting its epidemic and contagious character in passing from village to village, on the banks of the great Burrampooter, in Mymensing. It is probable, therefore, that at various points of Lower Bengal, about this time and afterwards, such an increase of the intensity of the endemic type of the disease has taken place as to render it contagious, and thus capable of spreading far and wide into other countries. Accordingly we find that its progress through the lower provinces of Bengal was perfectly irregular, and different from the whole of its subsequent courses; for it was found to appear and prevail simultaneously at distant places, and there was no possibility of tracing its progression throughout the country. But towards the end of autumn we find it extending in all directions from that tract as from a centre; reaching Chittagong on the eastern side of the bay of Bengal, Cuttack on the western, Sylhet and Rungpore far to the north-east and the north; and at the same time it is making a most partial and desultory course along the south bank of the Ganges to Bundlecund *.

* Bengal Report, p. 5, 7, 11.

In the spring of 1818 we find it reappearing at Allahabad, and extending from thence along the three great rivers of the upper provinces of Bengal, passing from city to city on their banks, yet often leaving places on its route untouched, but quickly retracing its steps to them. Thus it passed over Culpee and the villages between it and Etawah, and attacked Muttra before Agra, although the former is situated higher up the Jumna than the latter. Nevertheless the general tenor of its course is regular, and we find it as the autumn advances proceeding further and further up the rivers, until it is arrested by the Himalaya mountains.

At the same time another principal stream of the virus is found to proceed southwards through Bundlecund, along the Cane river, by Jubbulpore and Hosungabad, to the Mahratta capital of Nagpour; whence it is traced along the great road by Aurungabad and Poonah to Bombay; and at the same time we find it proceeding step by step down the centre of the peninsula.

In the spring of 1818 too, the epidemic starts up afresh about Ganjam, on the Coromandel coast, and holds its course through the low and level strip of country lying between that coast and the first line of inland mountains, along the great road from Calcutta to Madras, and onward to the very extremity of the peninsula. We have very full and precise accounts in the Madras Reports of the progress of this great stream of the virus, and the circumstance that most strikes us throughout them, is its general regularity and progressiveness. They are indeed such as to be somewhat inimical to the doctrine of contagion. Thus, the disease appears at once on the banks of the Kistna, all along the northern border of the province of Guntoor, and advances in a line on both sides of the road, through that district and the succeeding one of Nellore, involving as it proceeded the whole strip of country, except some rather elevated portions, precisely like a tide rising on a level coast — like the Runn of the Gulf of Kutch. As usual, it rapidly finished its course at each place, and left

them according to the order of its arrival; thus disappearing from the northern parts of a district as it reached the southern. In the district of Nellore too, the disease reappears in the following year, and spreads in the very same manner as at first, in the same direction too, from the northern to the southern border, and even at nearly the same rate of course.

To the southward of Madras similar regularity of progress has been observed. The staff surgeon of the Southern Division reports: "In my attempts to trace the progress of the epidemic through the country, I cannot perceive that it has advanced through any particular channel. It certainly appeared at Trichinopoly first, in the company of sepoys that had come in from the northward; but in a very few days after their arrival, the collector of Trichinopoly read to me a report from some populous villages on the north bank of the Cavery, and considerably to the eastward of Trichinopoly, quite detached from any frequented road, where the epidemic was then prevailing with considerable mortality. It seems also to have occurred in the line from Trichinopoly to Nagore nearly about the same period; and it is a singular fact, reported by Mr. Henderson, that the epidemic was severe in the town of Nagore ten or twelve days before a single case occurred at Negapatam, only four miles distant. It is also well ascertained, that when it has been very prevalent in one village, another in its near vicinity, with which there was free communication, has, for many days after, been entirely exempted. This was exemplified even in streets at Trichinopoly, one being sickly, and another immediately contiguous not affected*."

But in these populous tracts there is no difficulty in supposing that the disease was carried from village to village all over the country. It was certainly to be expected that it would travel somewhat more rapidly on the great roads; and I conceive there is considerable evidence that such was very

* Madras Reports, p. 137.

often if not generally the case. For instance: we know that it was conveyed direct from Madras to Trichinopoly by a company of the 25th N. I.; for it suffered from it on its route, the first case at the station occurred in it after arrival, and was immediately followed by others in the stationary troops and followers*. Accordingly we find that the disease began there considerably earlier than at various places much nearer Madras, but off the great road, as reference to the map will demonstrate. Another instance of irregularity of its course, even in those provinces where it appears to have been most regular, is stated in its having skipped from Verdoopetty to a village near Palamcotta, leaving a distance of sixty-six miles at first unaffected.

Another argument against contagion may be derived from the uniform and slow progress of the disease down this coast, evidently by land, when the greatest facilities existed for its rapid conveyance by sea; and this circumstance seems to have prevailed generally throughout India. Thus the epidemic existed in full force in Calcutta above a year before it reached Madras, or any other port of the southern part of the peninsula or Ceylon, though there is of course considerable intercourse between them, and no restrictions were practised. The disease took three months in passing from Masulipatam to Madras, though there is a great intercourse between these ports by small craft, which usually make the passage in ten days. So also, it never reached Ceylon until it had previously gained the nearest point to it of the continent, about Adam's Bridge, and had been long prevailing on both coasts of the peninsula. There is indeed great irregularity in the progress of the disease on the Malabar coast (as is shown by the map), which may have arisen from conveyance by sea; but it may also have arisen from the irregularity of the cross roads or offsets, by which this coast

* See Dr. Goldie's Report, p. 136. That gentleman's facts in favour of contagion may be received without question, for he was not satisfied of the contagious nature of the disease.

appears to have been infected. Besides, the disease was endemic on the southern part of this coast, whence evidently a part of this irregularity arose, as in the lower provinces of Bengal. Upon the whole, the consolatory fact (for islanders) is very evident, that the disease has in India shown considerable inaptitude to maritime conveyance, and a decided preference for its gradual locomotion by land.

There is however abundant proof that the intervention of sea has formed no permanent impediment to the progress of the epidemic. About the time that it reached the southern extremity of the peninsula, in December, 1818, it appeared at the northern extremity of Ceylon, and in the course of the ensuing spring and summer entirely overran the island. In October of that year, the Topaze frigate arrived at Port Louis in the Mauritius from Ceylon, having suffered from cholera on her voyage, and, according to one account, actually having sick of that disease on board on her arrival. Certain it is that she landed at Port Louis many sick men, and twenty days afterwards the disease broke out there, and shortly extended over the island. On the neighbouring island of Bourbon, the evidence in favour of contagion is exceedingly strong. One fact alone, as stated by M. Moreau de Jonnès and Dr. Keraudren, and which appears to be unquestionable, is the strongest I have met with on the subject, and fully shows the benefit that may, at least sometimes, be derived from quarantine. The disease was by that means prevented from spreading beyond the town of St. Denis, where it originated; whilst on the other island, and indeed everywhere else, it extended throughout the country. At Bourbon too the most unqualified assertions were made regarding the contagiousness of the disorder — that it was introduced by the clandestine debarkation of slaves near St. Denis — traced from case to case, and step by step over the city — that the prisoners who were employed in the removal of the sick and dead *all* died—the sick in hospital of other diseases were attacked, and almost all the attendants of the lazaretto were affected. But we know how warmly the French physicians of these islands

espoused the cause of contagion, and therefore their general statements, as well as those of the other party, must be received *cum grano salis*.

We have little precise information regarding the spread of the disease beyond the Ganges; but it seems to have extended gradually through these countries, at a rate of progress pretty similar to that which it exhibited in Hither India; for we find it in the autumn of 1819 appearing in the peninsula of Malacca, at Penang, and in Sumatra; and in the following autumn passing through Cochin-China into China itself, and reaching Canton; and for the next two or three years committing great ravages in that populous empire. The southern and western parts of the Archipelago seem to have been protected by their remote and insular situation from it for some time longer, for it is not until 1823 that it extends generally over them.

In attempting to trace its course in the opposite direction, beyond the precincts of the Bombay establishment, we find that a great dearth of information exists regarding its progress among the semi-barbarous hordes with whom it then came in contact; but it appears pretty evident that the red sandy deserts of Baloochistan and Caboul did not afford it the necessary vehicle of human intercourse, and that it never reached Persia by land. There seems to be no account of its farther progress westward for about three years; when we find it, in June and July, 1821, appearing in the three principal ports of the Persian gulf, Muscat, Busheer, and Bussora; places by which nearly all the intercourse between India and Persia and Arabia are carried on; and it appears in them shortly after the epidemic had, as usual, reappeared in the hot season in Bombay, with which place in particular these ports held great communication. It was likewise generally believed, particularly in Persia, that the disease had broken out in them immediately after the arrival of ships from Bombay: and having thus, at length, overstepped the natural barriers which were opposed to it, and gained a fresh footing in other populous countries, it again extended itself in various directions,

precisely as it had done in India; but by all accounts with a still greater degree of fatality. It is clearly traced up the Tigris to Bagdad, and thence, stage by stage, on the caravan route to Aleppo and the Mediterranean. Another stream of the virus in like manner passes northward from Busheer, by the great roads through the centre of Persia to the Caspian, and onward to Astrakan, which it reaches in the summer of 1823; but it then ceased for a long time to make any further progress. In the autumn of 1829, it makes a fresh appearance at Orenburg, at the south-western extremity of Russia in Europe, and this appears to be the only instance on record of a similar invasion, where any doubts can exist of the quarter from whence the disease was derived. It was however known to have prevailed shortly before in the parts of Tartary to the southward of Orenburg, and east of the Caspian, and there is every probability of its having been imported from thence by a caravan*. However that may be, no sooner had it gained head in that city, than it was found, as usual, progressing in different quarters through the province,—northward, north-west, and west, until it was extinguished by the winter. This insulated attack appears then to have finally ceased, and it is evidently to a fresh importation of it into Astrakan, in July, 1830, that we are to attribute the great epidemic cholera of Europe.

Whatever ignorance or disbelief of its contagious nature may have existed in India, notwithstanding the accounts from that country the prevailing opinion throughout these subsequent parts of its course has been, that it actually was thus propagated. It was immediately opposed by quarantine by

* One of the first cases here exhibited the curious phenomenon, which appears to be peculiar to the disease, of convulsive action of the muscles after death, resembling the effects of galvanism on the dead subject. The head and limbs are sometimes strongly moved several hours after death. It is a rare occurrence, for I have never seen it but in a very trifling degree. The physicians must indeed have been "startled at the new disease," when they found it attended by so extraordinary an appearance.

the governments both of Persia and Russia, and considerable evidence exists of such measures having been partially effectual. Thus it appears that Shiraz was by that means saved from it for one season; the very same circumstances occurred at St. Petersburg, and various insulated bodies of people have been thus protected in its course through Russia. And the Pacha of Egypt is stated by M. de Jonnès to have by this means saved his country from its ravages. But there is too much reason to fear that all human efforts will ever be unequal to permanently arresting its general couse. In July 1830 it commenced a fresh progress from Astrakan, of which most assuredly we have not yet seen the end. It passed rapidly up the Wolga, affecting in succession the towns on its banks, and seizing first on boatmen and others arriving at them from infected places. And thus it has continued to advance, through Russia and Poland into Germany; and is it possible that this can still be attributed to any cause but contagion? If the primary cause was some "hidden change" in the atmosphere, communicated gradually from portion to portion of it, or if it was of the ordinary nature of terrestrial miasmata, would not its progress have been hastened or retarded by the winds? Instead of which we find it marching from the sources of the Nerbudda, across a great variety of country to Bombay, directly opposed by a strong wind blowing night and day for half the year, at about the same rate of progress, but somewhat greater, than that which it exhibits in its course from Madras to Cape Comorin, where a similar current of the whole mass of the atmosphere existed in the very direction of its route. Then, if this very regularity of progress and independence of the winds should lead us to form the hypothesis that some "hidden change in the bowels of the earth," was thus gradually transferred along its surface, and even through the ocean to distant lands (credat Judæus!) why does it travel so rapidly from the southern extremity of Ceylon to Mauritius, 2500 miles, in eight months, or so slowly from Bombay to Muscat, about half that distance, which it took three years to

accomplish? Conveyance by human intercourse renders all this perfectly simple. It might be expected to be somewhat regular and slow by land in a populous country, such as India, when great intercourse by very short daily journeys on foot was continually maintained, and its conveyance by sea would be more irregular, as depending on the accidents of vessels making the voyage, and bearing with them or not fomites, or the disease itself.

The rates of progress of the epidemic, as well as its direction, have been exceedingly various in different countries. The following table, in which they are exhibited in those parts of its course where it has been most distinctly traced, in reference to both time and place, may possess some interest, and may possibly lead to some useful inferences.

Table exhibiting the rate of Progress of the Cholera in various Countries.

Distances traversed, computed in British miles (by the roads).		Periods occupied.	Course.	Rate, per week.
	mils.			mils.
Allahabad to Delhi	360	End March to 20 July, 1818	NW	22
Saugor in Bundlecund to Bombay, by Nagpour	750	1 April to 14 August	SW	39
Ganjam to Palamcotta near Cape Comorin (measured)	1050	20 March to 31 December	SW	25
Busheer in Persia to Yezd	410	— July to end of September, 1821	NE	32?
Cashan to Erivan	675	— July to end of September, 1822	NW	60?
Bussora to Bagdad	325	— July to end of August, 1821	NW	40?
Mosul to Aleppo	470	— July to November, 1822	W	28?
Astrakan to Moscow, by Saratoff	970	20 July to 15 September, 1830	NW	120
Astrakan to Odessa, by the Wolga and Don and the north shore of the Euxine	1070	20 July to 14 October	W	82
Astrakan to Pskov, by the Wolga	1600	20 July to 28 September	N,NW & W	160

It is perfectly evident that the progress of the disease through Russia last summer has been greatly more rapid than it was in India; which may perhaps have arisen from the more rapid communication which necessarily exists in civilized countries over those in the half-civilized state; but various other causes, as atmospheric influence, or differences in habits

of life or constitutions, may have been concerned in it. The course of the disease up the Wolga, and through the heart of the immense Russian Empire, is exceedingly remarkable. Between the 20th of July and the 4th of August it passes from Astrakan to Taratzin, and on the 6th is found at Saratoff. Thence it is traced northwards on a great road by Penza, which it reaches on the 17th, leaving to the right a great detour of the river; in the end of the month reaching Nishni-Novogorod on the Wolga, and in consequence of this transit, attaining that point a fortnight earlier than Casan, at the extremity of the bend. Continuing its course up the river, it arrives at Kostroma on the 3d, and at Jaroslaw on the 12th of September. Thence it is traced northwards on the great road to Archangel as far as Vologda, which it reaches on the 20th*; south-west farther up the river to Twer, not far from its sources, where it is found on the 28th; and westward to Pskov, within one hundred miles of the Baltic, which it attains about the same time. Had it continued this extreme rapidity of course for three months longer, that time would have been sufficient for it to overrun all Europe, even to the very straits of Gibraltar. But happily in the present summer its progress has been again very greatly retarded, and more resembles its more gradual march in India; whence a hope may arise, though a very faint and precarious one, that it is about finishing its course.

In India no measures of precaution against contagion appear to have been practised, with the trifling exceptions already stated; and there are few bodies of people at all separated from the rest of society, by whom we might learn whether segregation would afford any immunity from the disease; but in every district there is at least one large jail,

* It is very remarkable, that Dr. Walker, having traced it to this place in the winter of 1830, predicts that it would probably reach the distant point of Archangel, as it was on that route, before it arrived at Petersburg, which was much nearer; and this was next summer precisely accomplished.

where of course great restriction is placed on intercourse; and we certainly find, that in these communities remarkable differences in the times of attack from those of the neighbouring free population, or entire exemptions, are frequently observable. At Cannanore on the Malabar coast, the disease appeared in a suburb next to Tellicherry, a neighbouring town, where for some time it had been prevailing. For some days it lingered about the same spot, and then spread over the town, but it never reached the small fort (with I believe very few inhabitants) a mile to the north, until two months afterwards, when it broke out in the jail in the fort, and in the course of a week attacked twenty-nine of the prisoners, but never extended beyond the walls of the jail*. A similar fact was observed during a second visitation of Cannanore. The disease got from thence into the jail in the fort of Tellicherry, but was almost entirely confined to it†. So at Calicut the disease broke out in the middle of October, but the jail did not suffer till the end of December‡. So at Madura too, the disease appeared in the beginning of December, continued very prevalent in January, but did not reach the jail till the end of that month, from which time it attacked thirty-two, and destroyed ten of the prisoners in three weeks§. When the epidemic prevailed first at Bellary, though it affected the inhabitants and troops generally with some severity, the jail containing five hundred prisoners, which stood detached and surrounded by a high wall, entirely escaped except one case‖, which recovered¶. In Bengal too the same facts have oc-

* Madras Reports, p. 11. † Ibid. p. 232. ‡ Ibid. p. 11.

§ Ibid. p. 140.

‖ Single and straggling cases of cholera thus occurring are fairly attributable to atmospheric causes alone. It will subsequently be shown that an extraordinary prevalence of the sporadic non-contagious cholera has preceded the epidemic, and probably therefore has accompanied it, but it is impossible by the symptoms to distinguish one from the other.

¶ Ibid. p. 6.

curred. "In the great native jail at Alypoor, containing several thousand persons, scarcely a case appeared, whilst prisoners encamped at the outports, labouring in the sun and sleeping in mud buildings at night, were very sickly;" but this Mr. Jameson attributes to the airy situation of the jail. "So also the dry jail of the court of requests, containing four hundred prisoners, continued nearly exempt." "At Sarun, the only place left unaffected was the jail, which was clean, airy, and situated in an open space at a distance from other buildings. The same favourable localities nearly saved the Tirhoot jail. * * * So in Poornea, the lines of the provincial battalion and jail were quite exempt, when the disease was extensively fatal in the town. * * * In Furruckabad, the jail and the artillery barracks, the former containing six or seven hundred prisoners, had not a single case, whilst the Levy corps suffered severely." In Burdwan the same fact was still more remarkable. The disease is stated to have been there "dreadfully destructive;" and Mr. Jameson remarks:—"It is singular, that during the period of the greatest mortality, the persons mostly affected were the sepoys and well-fed inhabitants of the town, whilst the convicts and debtors in the civil jail remained healthy till the rains, when they alone were attacked*." At Goruckpore the disease was very severe, but the jail entirely escaped. Let it be remembered too, that the class of persons thus so often exempted were such as in other circumstances were found most susceptible; and when the disease actually did get footing in the jails it was often very destructive. I am well informed that it has prevailed annually in the "cholera season," for some time back, in the jail at Surat, and often when the neighbouring population were scarcely affected with it.

In ships at anchor in roadsteads, great restriction on intercourse must necessarily exist, and it seems to have produced evident effects on the mode of prevalence of the disease among them. Mr. Jameson states, that the shipping at the

* Madras Reports, p. 111, 135, 173. M. de Jonnès.

great anchorage in the Hoogly were visited by the disease in 1817, that it had prevailed among them with *great irregularity*, and that one vessel had entirely escaped, which he attributed to the men not being allowed to go ashore and wander in the rice-fields. Again, in 1819, "the Company's shipping at the new anchorage was again visited, during the squally irregular weather of September: as on the former occasion, *some vessels wholly escaped, and others suffered severely*. An instance has been related of two vessels in Madras roads remaining free from the disease, one for eight, the other for twenty-two days after arrival. But the troops brought by these two ships (the 54th regiment) were attacked on the third day after arrival and landing. So also on a wing of the 41st regiment landing at Madras it was immediately attacked, but the vessel which brought them was believed to have entirely escaped*.

In later periods of the progress of the epidemic, the preservative effect of insulation of bodies of people has been very distinctly shown; as in the clear facts stated by the London College of Physicians, of the colony of Sarepta and others, and the military school at Moscow being thus entirely protected from the disease, though it was raging around them. And nothing can be more strong than the following instance related by Dr. Keraudren. "In 1822, the approaches of the cholera induced M. de Lesseps, the French consul in Aleppo, to take refuge, with all who chose to accompany him, in a garden at a little distance from the town. His asylum was surrounded by walls and a wide trench. It had but two doors or gates; and while the scourge was abroad, he admitted nothing from the outside, without previously subjecting it to the precautions observed in the lazarettos. This colony of at least two hundred persons had not a single case among them, while in eighteen days the cholera swept off four thousand persons in the town."

* Madras Reports, p. 24, xliv.

These facts distinctly show the influence of separation, and give reason to hope, that where the restriction of intercourse is sufficiently strict, and the situation of the segregated body at a sufficient distance from infection, the disease would never be able to penetrate. Mr. Jameson, in arguing against contagion, says, "let the reader only call to mind the innumerable *detached spots* which remained free when all around was sickly, and remember, that in no single case was any restraint placed on free intercourse between the healthy and diseased." Of these he particularizes Sundeep, a populous island, lying off the mouths of the Ganges, which remained free notwithstanding full intercourse with the neighbouring islands, which were all ravaged. But the existing impediment to intercourse might have been sufficient to produce the effect; and that is the only probable explanation that can be given of the exemption. It is not to be supposed that any considerable difference of locality can exist among these low and level tracts, formed of the detritus of the continent washed down by the river.

It has already been stated, that the visitations of this epidemic have usually arisen and run on to their maxima of prevalence with great rapidity; but much variety is observable in this respect, which appears to be referrible to greater or less degrees of intercourse. Thus in some instances of single corps, as the 34th regiment, and in collections of them, as the Nagpour force*, the disease has attained its maximum of violence in about three days from its appearance; and in general in corps and camps, the rise and progress of the disease have been somewhat rapid, with a marked crisis, succeeded by a quick decline and disappearance. But in other large bodies of people, who were not thus compressed into a small space, and continually mixed together in the most in-

* This force was composed of two divisions, Bengal and Madras troops. The disease was one day later in attacking the latter than the former, and accordingly a day later in gaining its height in the division last attacked.

timate manner, as in the large cities and their wide-spreading suburbs, the mode of prevalence of the disease in these regards has commonly been very different. In these cases we never hear of this almost instantaneous rise and declension, and often they have been very slow and gradual. Thus it appears from the Bengal Report, that the disease visited some parts of the town and suburbs of Calcutta, as early as the beginning of August, but it was not till the 5th of September that it appeared among the Europeans; and on the 15th of that month it was first officially brought to the notice of government, in a letter from the chief magistrate, stating that it was raging with violence, especially in the low, confined situations; but it was still some time longer before it reached its maximum. The period of its declension is marked in a letter from the Medical Board to government, dated the 10th of November; for they then state that it was beginning to give way to the favourable change in the season. It did not entirely cease in its epidemic prevalence till February. Thus we find its progress to its height occupying about three months, and that it declines and lingers on for three months more; circumstances which form a striking contrast with the manner in which single corps usually got through their first visitations, for in them it seldom existed at all more than two or three weeks. The great protraction of the disease in Calcutta, has however probably been owing in some degree to local circumstances, for it is always endemic there to a slight degree; but in other great cities, in which it was before almost unknown, we observe circumstances somewhat similar. Dr. Scott, in a very valuable report, gives the following brief history of its first prevalence at Madras. "The earliest cases of the epidemic of which I could obtain any authentic information, occurred at this place on the 5th of October. The wind on that day was south-easterly, and the weather cloudy and wet, with much thunder. It scarcely cleared up for seven days, and during this period rain fell in considerable quantity. On the 7th, the north-westerly wind set in, and

the epidemic after that time increased rapidly; it received, however, a decided check from the storm that happened on the 24th, but it very soon again increased and raged severely, though variably (owing I think to some particular changes in the atmosphere) until the beginning of November. It then began to decline slowly, became some time afterwards milder, and sporadic, and at length seemed gradually to disappear, as the state of the air became more dry*.

In Trichinopoly also, and other large cities, which it would be tedious to particularize, we may observe similar circumstances—origin at a point; and gradual, often progressive and traceable extension over the whole, and more protracted decline and disappearance than in smaller and more compressed bodies. The regular march of the disease from one end to the other of the line of a great camp or cantonment, has often been noticed. Mr. Jameson states:—"In the larger divisions of the army the disease always began with one or two unconnected cases, slowly and gradually creeping on to inveteracy." * * * "To the same account" (infection created by large bodies of people) "may be placed the progressive extension of the disorder from one part of an infected place to another, as in the centre and Hansi divisions, and more particularly the Rajapootana force, in which the virus seemed to be regularly propagated from corps to corps†." Mr. Cormick relates, that in Tabreez, "the disease first began in that part of the city which is most low, filthy, and crowded with poor inhabitants; and advanced from quarter to quarter of it, finishing its ravages in one before it commenced them in another." And Dr. Scott mentions the various and partially detached suburbs of Madras being affected in the very same manner.

It is abundantly evident, that the latent period of this disease is very short. In numerous instances we find it appearing in a previously healthy body of people two or three days

* Report, p. 49. † P. 137—144.

after the arrival of infected persons among them, or the healthy body reaching an infected place. And from that time is to be deducted the accidental and inappreciable period elapsing between such arrivals and the reception of contagion by susceptible persons. Many instances also occur of the disease appearing within the day that the danger of infection is first incurred; and they are probably those where the virus was abundant, as in two instances on record, where corps encamped on ground just left by other corps, with some of their dead bodies still unburied on it. A wing of the 41st regiment landed at Madras, when there was no remarkable prevalence of the disease at the place; they were attacked three days afterwards: but the other division, landing eleven days after them, and consequently when the disorder was extensively prevailing in their corps, began to suffer from it on the very morning of their landing*. Girdlestone states, that more than fifty of the "fresh men" were killed by the disease in 1782, within three days after their landing at Madras.

There is, however, considerable proof, that on some occasions the contagion has remained in a latent state for a much longer period. Mr. Scot states, that a vessel sailing from an Indian port reached the equator before she was attacked by the disease, when it broke out with great violence, but ceased in two days. He does not mention the port from which she sailed, but it is not probable that she made the voyage to the line in less than a fortnight. We have also an account of a vessel (the Golconda) arriving from the Coromandel coast at the Cape of Good Hope, in 1819, with the cholera on board, with which she had been attacked on her voyage. It is probable that she was far advanced on the voyage when it appeared, for in so small and condensed a body as a ship's crew, it very soon runs through all the susceptible persons.

* Report, p. 23.

In these and similar instances, the virus may have remained latent in the frame until it was excited into action by a change in the atmosphere favourable to its development, or it may have lurked in fomites. It is exceedingly probable that it has been preserved in the latter mode for the much longer periods when it has been observed to remain in a dormant state, as in the winters of 1821 and 1822, in Persia and Turkey, where it was observed by Dr. Rehman to cease at several places at the setting in of the cold, and to reappear at and about the same places on the return of summer; and in the district of Orenburg, where it was found to appear at a place five weeks after it had disappeared from all the surrounding country*. That it should remain for these long periods latent in the system is highly improbable. Indeed it is not unlikely, that it is by means of fomites that the disease is in a great measure propagated over a country. During the existence of so acute a disorder, the patient is in no condition of conveying it from place to place; and if his power of communicating it is confined to the actual period of its existence in his frame, which we must suppose, it must be very short; for the attack is very sudden, and

"Citò venit mors, aut læta victoria."

restored health, or the grave, quickly put a stop to the fatal faculty of propagating the disease.

On these and other grounds we should expect to find the disorder more contagious in the colder countries than it has been in India. In that country, it is the custom to live almost entirely in the open air; the natives almost all sleep in it, as do many Europeans; and our large and numerous doors and windows are kept open night and day, generally with a highly evaporating wind blowing through them. No circumstances can be imagined more likely to dissipate contagion or infection: but how different is the case in Europe. What-

* Edinburgh Medical and Physical Journal, No. 108.

ever may be the reason of the disease remaining so long dormant, that fact greatly weakens our hope of quarantine measures being effectual in keeping it from our hearths. Infection by the person, indeed, they are likely entirely to prevent, but there is reason to apprehend that the other mode of conveyance may set them at defiance. On these points, however, we are almost in utter ignorance. We have no *proof* that the disease can be at all conveyed by fomites. The virus of cholera seems to differ from that of the plague inasmuch as it is capable of being conveyed by the atmosphere; it is therefore probably of a more volatile nature, and hence may further differ from it in being incapable of becoming fixed in fomites.

SECT. II.

OF THE INFLUENCE OF THE SEASONS AND EVIDENT STATES OF THE ATMOSPHERE, IN PRODUCING OR FAVOURING THE PREVALENCE OF THE DISEASE.

PROPOSITION IV. Great irregularity and intemperature of the seasons has preceded and attended the rise and first spread of the epidemic over India.

V. The disease has prevailed in India chiefly during that half of the year when the sun was on the same side of the equator.

VI. A high atmospheric temperature is a great cause of the disease.

VII. A condition of the atmosphere indicated by the formation of thick clouds, heavy rain, and storms (particularly thunder-storms), or the immediate approach of these phenomena, is a great cause of the disease.

We have been told that the different seasons of the year and the various states of the weather have no influence on this epidemic; and that equally sweeping and groundless assertion has been repeated in India, and echoed in Europe, *usque ad nauseam*. Even our most distinguished writers in this country appear to have received these statements without question, however contrary to all former experience in other epidemics. Sir G. Blane has inferred from these accounts, that "it prevailed to a degree equally violent at all seasons of the year: in regard to temperature from 40° or 50° of

Fahrenheit to 90° or 100°; in regard to moisture, during the continuance of almost incessant rain for months, to that dry state of the atmosphere which scarcely leaves a vestige of vegetation on the surface of the earth; and Dr. Good adds, "during all the changes of the moon, and in all states of atmospherical electricity." Mr. Scot too, who has performed his task of drawing up the Madras Report with a zeal and ability which entitle him to our highest respect—influenced, as it appears to me, too much by this prevailing opinion, which indolently shuts the door to all inquiry—infers, that "cholera has appeared and is equally virulent during all states of the atmosphere, amidst all diversities of the surface of the country, and under every variety of the circumstances of the people." Again: "The appearances of the epidemic at stations and in corps during cool and during hot weather are very nearly equal in point of number, but they have been doubly more frequent in dry than in wet weather." We shall see how all these general inferences agree with the facts on record, for a great number of which we are indebted to Mr. Scot himself. Even Mr. Jameson, though the continual tendency of the immense mass of facts which he brings forward is to show the connection of the disease with disturbed states of the weather, and a high atmospherical temperature, would throw us back into our original state of painful ignorance regarding it, by similar antithetical statements:—"Has it not in Bengal again and again risen and fallen and reappeared during all periods of the year, and under every possible variety of heat, cold, dryness, and moisture? In Upper India again, did it not, in Benares, Bundlecund, Oude, and the southern divisions of the Dooab, rage virulently during the dry months of the hot weather, whilst it appeared not in Delhi, nor in Meerut, nor in Jeypore, until the rains had set in, and the air was loaded with moisture? So, of the five camps visited by it, the centre division was attacked in the cold season, the Nagpour and Saugor divisions in the height of the hot winds, and the Rajapootana and Kurnaul divisions

whilst it poured down rain*." There is doubtless much truth in these and the preceding general observations and infer-

* Of these five camps, the only instance that makes against the inferences here supported, is that of the centre division. It is the anomaly which I have already noticed at p. 300 of the original work, and certainly shows the disease to have existed to a tremendous extent at a most unusual season of the year, in a cool, clear, and undisturbed state of the atmosphere, excepting partial thick fogs in the mornings. It was however attended by other circumstances, which mark it out as a particular case. It was an almost isolated attack, for the disease did not exist, at least to any extent, in the surrounding countries, so that none could tell from whence it came or whither it went. Nor did it subsequently spread in the neighbourhood, though five thousand persons deserted and dispersed themselves over the country. The intercourse between Allahabad and the camp was very great, yet the disease reached not the former place till four months after (see Mr. Spilsbury's paper in Trans. of the Med. and Phys. Society of Calcutta, August 1829). Even some corps of the division stationed at a little distance escaped, though an infected party arrived among them from the main body. It was therefore at this time incapable of spreading beyond the camp by contagion. It is probable that the attack was owing chiefly to local malaria, combining with a high state of predisposition from the fatigue the army had previously undergone. Mr. Jameson states—"In the three grounds of encampment in which the disease prevailed most, the soil was low and moist, and the water foul, stagnant, and of brackish quality, and everywhere not more than two or three feet from the surface of the earth, and the vicinity abounded in animal and vegetable putrified matter; whereas at Erich, where the army regained its health, the situation was high and salubrious, and the water clear and pure from a running stream" (p. 116). It will subsequently be shown how very marked has been the influence of malarious situations in producing the disease. Bishop Heber states, that the "Essence of Owl," or visible malaria (as it is deemed) at the foot of the Himalaya mountains, has the appearance of a thick, whitish mist near the ground. The fogs which are mentioned as attending that attack may have been of that description. Another of the camps was that of Nagpour, which was attacked during excessive heat, immediately before the setting in of the rains, as I have already noticed. Another was the Saugor (left) division, and Mr. Jameson informs us, at p. 161, that the prevalence of the disease was there attended by daily storms of thunder and rain. And, with regard to the other more

ences, but they are carried infinitely too far. I will not now assert that atmospheric influence is *always* necessary to the production of the disease; contagion acting upon a high degree of predisposition from other causes is probably sufficient to produce it, independent of that influence; but we shall see as we proceed how rarely that has happened, and that the different states of the atmosphere actually have an immense influence in producing or removing the disease. Indeed, so clear and evident are the facts connected with this part of the subject, that it is to me a matter of surprise that the public should to this day be either ignorant or incredulous of them—that in this fifteenth year of the epidemic, all the inquiries that have been made into its etiology should still have ended in NIL NISI DEDECUS.

A high atmospheric temperature is well known to be a principal cause of the sporadic cholera of Europe, and Sydenham has observed a connection between its prevalence and heavy falls of rain. That disease appears to differ from the epidemic only in degree (unless it be in the absence of a contagious quality); but the sporadic cholera of India is still more closely allied to it, for in the symptoms no distinction can be drawn between them; it is therefore of importance to this inquiry to ascertain at what seasons of the year and under what circumstances that endemic form of the disorder is found to prevail. It is rarely met with, except in certain tracts of country, as the lower provinces of Bengal, Chittagong, the east coast of Ceylon, the province of Travancore, and (according to Sir J. Malcolm) certain woody and highly mala-

general notices in the same paragraph, of the prevalence of the disease in dry and hot weather in the Dooab, Oude, &c., various statements incidentally occur, showing that in these tracts the disease was attended by equally remarkable atmospheric disturbances, as well as by great heat: thus it is stated at p. 93, that "the inhabitants of Agra and Futtigur, were suddenly and largely affected (that is, within a few hours) in such manner, that the attacks were clearly referrible to corresponding sudden changes in the sensible properties of the atmosphere."

rious parts of Malwa. Mr. Jameson states, that "it has prevailed more or less endemically during the hot and rainy seasons of every successive year in the lower provinces of Hindostan. It rarely appeared in the dry and equable months of the cold and hot weather; and although cases were now and then met with during every part of the rains, it always showed itself in the greatest vigour towards the autumnal equinox, when the declination of the sun was still inconsiderable, when the air was surcharged with moisture, and when the alternations of atmospherical temperature were sudden and frequent. As the cold season came round, and brought a clear atmosphere, and cool, dry, and steady weather, the disease became of less frequent occurrence, and at length altogether withdrew*. He farther states: "If we were to look for an epitome of all that composes the exciting causes of cholera, we need only refer to the appearances presented by the Chittagong district during the hot season of every year." He describes it as a jungly country, interspersed with flats of rice-ground, which dry up in the hot season. From the month of March the atmosphere becomes moist and cloudy, with great heats and occasional falls of rain, and great vicissitudes of temperature. * * * * * "This disease is therefore endemical in the district during the hot weather of each year, and does not subside until the air is cooled, and the atmospherical temperature becomes more even after the full setting in of the regular rains†."

Sporadic cholera is rare at Madras; but Dr. Scott states, "I have in repeated instances seen natives attacked suddenly when the weather was moist, and the temperature variable, with watery purging and cramps; and I am informed it is not uncommon to meet with similar cases after a heavy fall of rain in the hot season, or during the periodical rain, attended with sudden depression of strength, and other symptoms bearing some affinity with those of cholera spasmodica."

* Report, p. 1. † Ibid. p. 155.

Mr. Craw states, in the Bombay reports, that he had met with numerous cases of sporadic cholera near Bombay, in the rains of 1817. Bontius states the principal causes of this disease at Batavia almost in two words—"a *hot* and *moist* disposition of the air." The staff-surgeon of Travancore reports, that a disease perfectly similar to the epidemic prevailed endemically in that district; that it bore the name of *veshoo-ugeeka*, or poisonous air; and that a very dangerous modification of it was termed the "red-eye sickness"—doubtless those protracted cases in which inflammation of the brain so commonly occurs. He states that it had prevailed severely in May, 1817, having destroyed a hundred persons in the capital. That month is the hottest in the year.

I have already noticed various instances of former partial prevalences of epidemic cholera in India, with their attendant atmospherical phenomena. Two others occur in Mr. Jameson's work. The first was in a body of five thousand troops at Ganjam, in 1781. "It assailed them with almost inconceivable fury at that place, on the 22d of March. Men in perfect health dropt down by dozens; and even those less severely affected were generally dead, or past recovery, in less than an hour. Besides those who died, above five hundred were admitted into hospital that day. On the two following days the disease continued unabated, and more than one half of the army was then ill." It was at first attributed to poison, but it was soon discovered that the disease existed in the villages on their route, prior to their reaching Ganjam. There is no precise information of the state of the weather at the time, but it is stated that "they had been marching almost incessantly for six days through sand and salt water; a violent wind blew day and night along the whole shore, and at night it was accompanied with such a penetrating moisture as to wet through the thickest woollen cloths." It is proved by a letter of the Indian government, that the disease spread from thence to Calcutta—a course directly opposite to that of the epidemic of 1817—and after committing great ravages among

the natives there for a fortnight, pursued its route to the northward. The other instance occurs in another large force marching through the same district in the end of March, 1790, the very same time of the year. "The weather was excessively hot, the thermometer rising to 124°; the nights were close and sultry in the early part, and damp and chill towards morning. The atmosphere was during the day overshadowed with thick white clouds, and loaded with vapours. The disease did not become general till the 15th of April, when its activity was heightened by a heavy squall of wind and rain, which overtook the detachment at Manikpatam, on the north side of the Chilka lake. From this time till the middle of June, when the weather had become more moderate from frequent falls of rain, the disease proved very fatal *."

In the Madras Reports (p. 234), is related a curious instance of the disease having prevailed to a great extent in a corps on its march southward from Jaulna in 1814; ninety-nine cases of it having occurred in sepoys alone, in a fortnight, of which fourteen were fatal. A very remarkable, and, in the present state of our information on the subject, inexplicable circumstance, is, that the disease was entirely confined to the corps, the places on their route being and remaining entirely free from it; and even another corps of native infantry, marching in company with them, enjoying the same immunity. No circumstances of food, drink, or situation, peculiar to the suffering corps, in the smallest degree likely to produce the effect, could be detected.—Had it recently come from a malaria station, or been suffering severely from fever, whilst the other had not? In that case, the peculiar prevalence of the disease in it would have been in perfect accordance with facts observed since the great appearance of this epidemic. It is further remarkable, that the particular prevalence of cholera is noticed as occurring in another corps at Jaulna (the 24th) at the very same time, that is, after being left there by these

* Bengal Reports, p. xxii, preface.

two corps. The states of the weather attending the march of these two corps are described at some length. For some time before the epidemic appeared, the thermometer had been rising in the best tents to 106°. On the 7th of June, the temperature was greatly reduced by heavy rain, but soon returned to its former intensity. On the 13th, it was again reduced by rains to 85°, and on the following day the epidemic appeared. No farther mention is made of the weather during the fortnight the disease prevailed, but in the beginning of July, it is stated that it was with great difficulty they were able to proceed, from the swollen state of the rivers and flooded roads. These were the commencement of the great Rains. But notwithstanding these circumstances, the cholera disappears, and is succeeded by a very prevalent diarrhœa or dysentery, *equally affecting both corps.*

Thus it appears that the occurrences of this disease in India, whether in its sporadic or epidemic form, prior to 1817, as well as of the cholera of Europe, have been in the most marked manner attended by the conditions of the atmosphere described at the head of this section. Let us now see what farther evidence there is of atmospheric influence producing or favouring the prevalence of the great epidemic. I fear the reader will be wearied by the continual repetition of the same facts; but as they are not known or not appreciated by the public, I must be excused for dwelling upon them at some length.

It appears from Mr. Jameson's very clear accounts of the states of the seasons preceding and attending the rise of the epidemic, that the year 1816 was exceedingly remarkable for its deviations from the ordinary regularity of their course. A great drought with excessive heat prevailed till the setting in of the rains in June. An earthquake occurred in Bengal in April, and another in July. A second great drought took place in the middle of the rainy season, which was followed in September by a deluge of rain, occasioning "such an inundation as was not in the memory of the oldest inhabitants."

These circumstances, however, resulted not this year in the production of cholera, but of a bilious remittent fever, which raged generally through Bengal, but particularly the upper provinces. At Cawnpore it was attended with a mortality said to be then unprecedented in the annals of the country. A similar epidemic prevailed at the same time in Kutch, Sinde, and other countries about the Indus. "In February, 1817, the singular deviations from the ordinary course of the seasons which marked that year began, for that month had more the appearance of an autumnal than a cold weather month. It rained heavily every third or fourth day." March was remarkable for thunder-storms, very heavy rains, cloudy alternating with clear weather, and southerly winds. "The same kind of weather prevailed during the whole season, over that side of India, and from Loodianah to the Presidency, there was scarcely a district or village in which the prospects of the harvest were not blasted by the heavy falls of rain, and long-continued humidity of the atmosphere." The two next months were not very different from those of ordinary years, the weather being very hot, and broken by occasional storms and falls of rain. The rainy season set in twenty days earlier than usual, and proved to be one of uncommon violence. "In June and July there was hardly a dry day, and before the end of the latter month the river was quite full, and the country nearly under water. In the districts of Jessore, Backergunge, Nuddea, and every portion of the Gangetic Delta, there had been a long protraction of very heavy rain; and nearly the whole country, especially in the lower division of the province, was one sheet of water before the middle of August. In Nuddea the whole year had been rainy and damp, and in every week of April and May there was a succession of thunder-storms. It was calculated on the whole, that one hundred and twenty inches of rain fell." Another extraordinary circumstance was the great partiality of those rains, for whilst the Delta was thus drowned, the neighbouring district of Dacca remained free from rain from the 10th of

July to the end of September, and Sylhet had not had a shower for five or six weeks before the 5th of October, when it was inundated in its turn.

It was about the end of May or beginning of June that the epidemic was first observed to arise ; that is, just at the commencement of this extraordinary rainy season; and it was in that very district of Nuddea, so particularized, that attention was first excited to it, for its usual endemic prevalence was then found to be increased to an extraordinary degree. It is however shown that this was far from being its sole local source. Such and so striking being the circumstances attending the rise of the malady, and its first and principal ravages all over Lower Bengal, we may fairly infer that it was owing to this exaltation of the common causes of the endemic or sporadic disease that it took on the epidemic and contagious form, and thus became capable of diffusing itself far and wide over the earth.

It next becomes an interesting object of inquiry, whether the virulent disease thus produced was capable of extending to other countries in natural and ordinary states of the atmosphere, or whether it required a departure from them, similar to that which produced it, to assist its progress. As far as our experience or information in India extends—which indeed are but of one year—the epidemic has been accompanied in its progress through countries where it was before almost unknown, by circumstances somewhat similar to those which attended its birth; and it is in the highest degree probable, that but for these favouring circumstances it never could have extended itself over India as it has done ; for it has often before prevailed as an epidemic in various parts of that immense country, but never generally, at least as far back as history affords any accounts.

In the year 1817 the epidemic did not extend far beyond the lower provinces of Bengal. In the following year there were again in that country marked irregularities of the seasons

and excess of rain*. This state of things therefore is co-existent with the march of the epidemic from the great bifurcations of the Ganges northward into the upper provinces, and southward through Central India, and its other invasion of the Peninsula from the neighbourhood of Calcutta. I have already shown, that at Madras and Bombay the quantities of rain which fell in 1818, when the epidemic overspread these establishments, greatly exceeded the usual averages. At the former capital, the fall of rain was also in part at a most unusual time of the year. Mr. Annesley states, in his work on cholera: "1818 was similar to the preceding year. There were excessively heavy falls of rain at Madras, from July to January, a great deal of thunder and lightning, and a severe hurricane in October" (when the epidemic was prevailing there).

The degree of the dependence of the epidemic on atmospheric influence in its first spread over a country is however quite undetermined. Its progress from one extremity to the other of the Peninsula in nine months, at a pretty uniform rate of course, would lead us to suppose that it was not great; but let it be remembered, that it was favoured in that course by the great heats and disturbed weather preceding the south-west monsoon, by that monsoon itself, and on its reaching the southern parts, by the north-east monsoon, which attended the rest of its progress; and (as just shown) that these seasons were unusual. It appears further, that a deviation from the ordinary seasons has taken place on the southern part of the Malabar coast, which may account for the disease partly prevailing in this tract of country in November and December, when there is usually nothing but cool clear weather. I have already shown, that in the end of October the 69th regiment experienced excessive rains together with the epidemic in that tract, and that the same thing was observed in November at Manantoddy, in the Western Ghauts, which, like the Andes,

* Report, p. 63.

run down that side of the Peninsula. When the disease reached the coast at Cannanore and Tellicherry, in the end of November, the staff-surgeon there reports—"A much greater quantity of rain than usual had fallen in the last monsoon; and the weather at Cannanore during October and the greater part of November was sultry and calm, but the land wind began to blow with some force towards the end of the latter month, and the atmosphere became loaded with clouds for a few days, from which we had a little rain. About this time too it reappears at Mangalore, eighty miles to the north, which it first reached about two months before.

One of the strongest proofs which I have met with of the influence of the seasons or atmospheric states on the disease, is a general suspension of its prevalence and arrestation of its course, which took place in the cold and dry months of 1817 and 1818. This important fact has not been hitherto noticed by other writers; indeed, so little have these circumstances been inquired into, that M. Keraudren draws an argument against the influence of temperature and other atmospheric conditions on the epidemic, from its supposed prevalence through those very months: — "moreover, the disease has experienced no interruption to its continuance from changes of the seasons, having raged during the winter months of 1817, 1818!"

It has already been seen, that in the autumn of 1817 the disease had progressed in all directions from the Delta of the Ganges, and in particular had made a longer, but very irregular course westward, on the south bank of that river. In tracing its progress in this direction, Mr. Jameson, after mentioning a very great number of its general attacks occurring in August and September, and a few in October, seems to find its traces becoming very indistinct. The following is his notice of its spread in November: "although the epidemic would seem to have beset Mirzapore, and to have slightly appeared at Oonchara, and at Mongawa, near the northern extremity of Rewa, about the middle of November, it did on

great mischief until the end of the first week of that month when it reached the centre division of the grand army, then encamped under the personal command of the Marquis of Hastings, on the banks of the Sinde in Bundlecund." After detailing the circumstances of that dreadful attack (which we have seen was confined to the camp), he continues his narrative of the course of the epidemic, but it is not until March 1818 that he resumes the thread of its progress. In fact, it is evident that it did not exist in the epidemical form in the whole surrounding country during the intervening period. In the early part of March we find it re-appearing in the very neighbourhood where it had been lost so long before, that is, on the Betwa in Bundlecund. Thence Mr. Jameson traces it *eastward*, to Banda on the Cane, which it reaches in March; and in the end of the month we find it appearing at Allahabad, eighty miles further east*. And from the latter two places, and those times, it pursues its regular uninterrupted progression, as related, through the upper provinces of Bengal, and the central and western parts of the peninsula. In the other stream of the virus, proceeding along the great routes from Calcutta to Madras, the same arrestation from the influence of season takes place at the same time. A single glance at the map will show the fact more plainly than I can state it. In the latter end of September the disease reaches Cuttack, and on the 20th of March following it has got no farther than Ganjam, that is, about eighty miles in six months; but in the next six months it overruns four-fifths of the peninsula. And we find that in the early part of this course, whilst the season was still unfavourable to it, its progress is much slower than afterward. It is in vain for us to look for any similar distinct interruption to the progress of the epidemic in the cold season of 1818-19, for the accounts of its farther extension both eastward and westward are extremely defective; and by the

* Here we find it travelling a considerable distance in the opposite direction to its original and principal course, and again in the following year it is found passing *northward* from Nagpour into Bundlecund.

end of 1818 it had reached Cape Comorin. It immediately passed over the strait, but it does not appear to have prevailed in the island to any considerable extent until the hot weather. Mr. Marshall, in his valuable Medical Topography of Ceylon, relates, that it appeared in Kandy about the end of February, and in March and April visited most of the ports in the interior of the island, abating towards the end of May. He observes, that he was unable to perceive its connection with the states of the atmosphere, but in another place he mentions that much rain fell in March and April, which would appear to be sufficiently remarkable, as that was not the rainy season.—P. 110, 111, 191.

The influence of season on the disease during its progress through Persia and Turkey, appears to have been at least as evident as in India; for it appears from the statements of Dr. Rehman that in the whole of its course, for three years, from the shores of the Persian gulf to the Mediterranen in one direction, and to the borders of Russia in Europe in the other, it prevailed *only in summer*. It first appeared in these countries in 1821, at Muscat, a place so notorious for heat that it is termed "Hell" by the Persians, and during a season of extraordinary heat. In the course of that summer it extended from Busheer as far as Yezd in the centre of Persia, where it ceased in the winter, and reappeared at the same place early in the following year. At the same time it extended in the other direction from Bussora as far as Bagdad, where also it is lost towards the end of the year, and in like manner reappears at Mosul, higher up the Tigris, in the following July. In that summer it travels from thence to Aleppo, and from Yezd to Ghilan and Mazenderan, on the southern shore of the Caspian, at all which distant places it again ceased on the approach of winter. In June 1823 it reappeared in the neighbourhood of Aleppo, and prevailed to some extent on the Syrian shores of the Mediterranean; but in this direction its progress finally ceased in that year. In April 1823 it also re-

appeared in Mazenderan and Ghilan, extended along the western shore of the Caspian, and reached Astrakan in September. It had then attained the 46th degree of latitude, and its virulence seemed completely exhausted. It shortly ceased, after destroying only one hundred and forty-four persons in that city, and extended no farther. And as it ceased to advance for six whole years, the few who were watching its progress doubted not that it had at length reached its *ultima thule*, being incapable of existing in the more temperate regions of the north. But we were then, and probably still are, very imperfectly acquainted with the capacities, the habitudes, and strange varying features of this *Avatar of Siva*—which, like that stern deity, with his crest of snakes and necklace of skulls, seems to have a great propensity to *stalking round the earth.*

To return to Bengal. There are some striking facts, showing the influence of the seasons on the epidemic, which may be compressed into a very small compass, and embraced by the mind at once. Mr. Jameson, in the course of his work, mentions one hundred and twenty-nine separate instances of the appearances or reappearances of the disease, in different camps, cities, or districts in Bengal, in 1817, 1818, and 1819, with their dates, or the approach to them. The number of attacks in each month is as follows:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	3	10	18	23	14	10	22	16	7	5	0

Thus we find the hot and wet months, from March to September, vastly more obnoxious to the disease than those of the opposite description. For in that half of the year, when the sun is north of the equator, the number of attacks is

one hundred and three; whilst in the other half, when that luminary's vertical influence is withdrawn, and he is exerting his heating and deluging powers on the southern hemisphere, the number is no more than twenty-six. And if we include March in the obnoxious months, which it certainly is, being the commencement of the hot weather, the average number of attacks for each of these seven months is sixteen, but that of the other five months is only three! Let the reader refer to Mr. Jameson's work, and he will also find, that the number of attacks occurring in the cold and dry months, November, December, January, and February, with that probably single exception which has so often been noticed, have been of a trifling nature, and that its great visitations have all occurred at very different periods.

A clear line of distinction is to be drawn between the first attacks of the epidemic on any considerable body of people, and its subsequent revivals or reappearances. In the first case it reaches these masses in succession, in its more or less regular course over the country; and meeting with a great number of susceptible persons, from the general body not having previously undergone the disease, it probably in general has arisen among them (during at least the principal part of the year) immediately on, or shortly after the application of contagion. But after the first attack, this great original stock of susceptibility is exhausted, and contagion having been then universally disseminated, is almost always present in any great collections of people; as we see from the straggling attacks constantly occurring in the great cities or camps, and indeed generally;—as if the Spirit of Destruction was continually lurking among us, in expectation of the return of favourable circumstances to enable him to renew his attacks. It may therefore be stated generally, that the exciting cause of the first attacks is the importation of contagion; whilst that of the revivals or returns is atmospheric influence. Consequently, the circumstances attending these reappearances are especially instructive of the nature of that influence.

The epidemic began its ravages on the peninsula about the beginning of April, and before the end of September had overrun four-fifths of it; or nearly the whole, excepting that portion which lies south of a line drawn from Madras to Mangalore. The number of attacks in the summer months would therefore probably bear that proportion to those of the rest of the year; and the latter were chiefly owing to the influence of the north-east monsoon (which lasts till the end of the year). But leaving out these first attacks, for the reasons just stated, let us see at what times of the year the others have occurred. Mr. Scot, in the course of his work, gives the dates of fifty-one of those reappearances, among the stationary troops, or inhabitants of places on the peninsula, in 1819 and the four succeding years. The number occurring in each month is as follows*:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
6	1	3	6	8	10	7	2	3	2	2	1

The anomaly which appears of so great a number of the attacks occurring in January, is owing chiefly to a remarkable revival of the epidemic, which took place in various parts of the great plain which forms the south-eastern division of the peninsula, about the middle of January 1819. But these cases might have been omitted, as exhibiting only an increase or exacerbation of the original attacks, which had then scarcely subsided. Giving however the full force to the objection, the influence of the times of the year is abundantly evident,

* The attacks occurring at the same time at any two places within one march of each other, are set down as single.

in perfect accordance with the corresponding facts observed in Bengal.

Mr. Scot also relates thirty-four instances of serious epidemical attacks, occurring in as many corps on their march, in the years 1819, 1820, 1821, and 1822, which may be similarly collated. The number of these attacks in each month is as follows:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
2	1	2	2	10	6	4	1	1	1	3	1

The same results are here perfectly evident. Mr. Scot also mentions twenty-six instances of corps making marches of considerable length, yet escaping or suffering but slightly from the epidemic, with the times in which they were performed. Collecting all the months in which each of these corps was thus marching without the disease, I find the number of times in which each month occurs in that aggregate to be:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
9	11	5	1	2	3	3	3	6	5	7	5

Thus the converse of the rule is found to apply to these cases, and equally to support the conclusion. It appears also distinctly, from Mr. Scot's narrative, that the months in which the entire exemptions took place were those most generally unfavourable to the disease, November, December,

January, and February, and that the partial attacks have generally happened in the other months. It must however be stated, that some of the severe attacks included in the preceding table have occurred in these generally cool and dry months.

Mr. Bell states, in his work on cholera (p. 82), from his personal experience, that the epidemic has reappeared every year, from 1819 to 1824, in the southern Mahratta provinces (to the eastward of Goa) in the months of April, May, and June.

It has been shown, that the epidemic died away in Calcutta as well as other places in the cold season of 1817-18. Let us now see under what circumstances it resumes its fearful activity. Mr. Jameson observes: "The first part of February was cool and clear, with moderate winds, chiefly from the north and west, and frequent thick fogs. From the 19th the wind settled in the south, the thermometer rapidly rose from 70° to 80°, and the hot season might then be said to have set in. On the 25th there was a north-wester (a storm), and on the 27th and 28th much rain. This sudden change about the 20th of the month is worthy of particular notice, because it was at this very time that the epidemic, after dying away in November and December, and being nearly extinct during January, again took head, and raged among the natives with indiscriminate violence till the end of the following July. It appeared to have gained fresh malignancy by lying for a time dormant*." March is described as a very disturbed month, with fogs and much rain, and a hurricane on the 28th. It is then stated that the epidemic was becoming very prevalent in Europeans, fresh cases every hour pouring into the hospitals.

Again, in 1819: "The month of March was hot and dry. April, on the contrary, was unusually cloudy, with frequent storms, heavy rain, and strong gales from the south-east and north-east, hot unpleasant days and cold chilly nights. Ther-

* P. lxiii.

mometer from 76° to 86°. The 7th, 8th, 11th, and from the 17th to the 23d, were all rainy days. On the 7th and 23d, the rain was very heavy, and on the 22d incessant. These details are entered into, because this falling back of the weather to its old irregularity had an immediate effect on reviving the epidemic*. Many cases and some deaths occurred during the first twenty days of the month, but it again withdrew as the month of May brought round steady southerly winds and settled weather."

Mr. Jameson subsequently states: "we shall find that great and sudden vicissitudes of the weather from hot to cold and from dry to moist, accompanied with changes in the directions of the winds, were almost uniformly in operation wherever the epidemic showed itself, and were generally the immediate precursors of its visits. It has already been shown, that in Calcutta and other divisions of Bengal, its first rise was preceded by a long course of unusually sultry and humid weather, and that its subsequent periods of increase and decline were always modified by changes in the weather. Thus in February, 1818, and April, 1819, the two most marked periods of its aggravation, the days were sultry and the nights cold and raw, with heavy storms from the south and east. So it was in almost every part of the lower provinces: in Jessore, Burrisaul, Dacca, Sylhet, Chittagong, Nuddea, Rajshahy, Bhaugulpore, Monghyr; as well as in the valley of Khatmaudoo, and in many other stations. At Patna, the weather had been very hot and dry some time before its appearance. At Futtygur, the weather had been insufferably hot, and not a drop of rain had fallen for a month; when a heavy north-wester occurred on the afternoon of the 9th of

* "The same unsteady weather and sudden vicissitudes of temperature, probably extended all over Bengal, as the medical returns for the month show, that the epidemic was at this time on foot in Sylhet, Dacca," &c. (eleven other districts of Lower Bengal named, and two great camps about the Nerbudda).

June, and next morning the epidemic was first seen. So in Agra, the morning and day of the 1st of July were exceedingly hot; the thermometer stood at 96° in the shade; and not a breath of air stirred. At six P. M. a great storm from the east suddenly came on; the air at once grew damp and chilly; and the next morning many persons were carried off by the epidemic. And during the whole period of its continuance, the days were very hot, and the nights cold and moist, with a keen penetrating wind; the thermometer ranging from 84° to 94°. But as the wind came round to the west, and the weather became steady, the disease withdrew." So with the 1st battalion 6th regiment in Malwa: "This corps on the 4th of May encamped on the high banks of a dry river-bed at Jhanoor near Ougein. The day was excessively hot; at five P. M. heavy rain came on, and the thermometer fell suddenly from 100° to 80°. The disease, which was not then in the neighbourhood, attacked the detachment next morning*."

The epidemic reappeared in the Rajapootana force at the setting-in of the rains in June, 1819. The weather was cloudy and sultry, with frequent thunder-storms and showers, variable winds, and but little fluctuation of the thermometer, which usually stood at 81° at sunrise and 97° at noon. The disorder appeared to abate after a long and heavy fall of rain†. In like manner it was found to reappear about the same time at Agra, and to disappear in about a fortnight, after several days heavy rain. In August, 1819, it reappeared at Meerut, and committed great ravages in H. M. 14th regiment. A long detail is given of the weather at the time. It was damp, sultry, and oppressive, with daily heavy rain when the disease was at its height, but without remarkable fluctuations of the thermometer. "On the morning of the 21st a steady breeze sprung up from the east, and brought with it clear weather, and happily from this time the disorder declined

* P. 156, 162. † P. 303.

quickly, and soon after entirely disappeared." At the same time it at length penetrated into the mountainous region of Almora, in that neighbourhood, and disappeared in about three weeks, after a great fall of rain from the east*. Many further instances of a similar nature might be adduced from the same work†. M. de Jonnès mentions the epidemic being accompanied by a great inundation in Assam in 1823.

* P. 310, 313.

† I am already deeply indebted to Mr. Jameson's work, but must farther take the liberty of enriching my pages with the numerous facts contained in the following note, regarding the reappearances of the disease. "From August, 1818, until the following April, when it recurred with considerable violence on occasion of some variable, unseasonable weather, only a few cases came to notice in Calcutta. Now (May) it has again subsided; but fresh instances of the malady are sure to occur as a consequence of the sudden vicissitudes in the atmospherical heat and moisture, produced by every north-wester. In the Backergunge district it remained until the end of last year, since which time it would not appear to have done much injury. In Bullooah and the tracts near the mouth of the Ganges, it began in February and terminated in June, 1818. In different parts of Mymensing it has existed since June, 1817. So likewise in the city and district of Dacca. In Tipperah, after wholly disappearing during the cold season, it returned in March, 1818, and remained till the breaking up of the subsequent rains, from which time it seems again to have retired. In Sylhet its career has been singularly various; after retiring in October, 1817, and being for several months dormant, it returned in the end of March, and subsisted till the setting-in of the rains, when it a second time nearly disappeared. But about the middle of October, it suddenly increased all over the district to as great a degree, and with greater fatality than on its first appearance. It again withdrew in the end of the year. Finally, it made its fourth visit in the commencement of the present hot weather, but not generally. In Rajshahy it prevailed most in September and October, and disappeared about the middle of November, 1817. It again appeared in the following hot weather, and frequently proved fatal. In commenced in August in the city of Moorshedabad, and has continued till now, but always in a very mild shape. In Nuddea, as we have seen, it began generally in July and August. Towards the latter end of the year it became less severe. With the heavy rains which set in towards the end of the following

Dr. Adam, in a valuable article on Indian cholera, published in the London Medical Journal, No. cclxxxiii, states: "As far as observation goes, the prevalence of the disorder appears in some degree connected with a certain state of the atmosphere, and cases were most frequent on any change of weather. Dense, detached clouds were common precursors of cholera."

February, it recurred in various parts of the district. As in Calcutta, it declined in August following, was very rare in the cold months, and again got head in the beginning of the present hot weather. In Burdwan a few cases happened early in the rains. In September the mortality caused by it was alarming, and from that month until the end of the following year, few days passed without the disease appearing in some of the villages. It was particularly violent in the commencement, and at the termination of the hot winds. Since January, 1819, no account of its progress in that quarter has been received. In the district of Bhaugulpore it continued its ravages without intermission from August, 1817, to May, 1818, when it considerably abated, and from that time till now only occasional cases have occurred. At Monghyr it began in the latter end of August, decreased in October and November, was not heard of in December, returned partially in January and February, increased much throughout the hot weather; and, finally, altogether withdrew in September. In Behar it began in August, nearly disappeared in the cold season, recurred about the 20th of February, and continued active till the ensuing November, when it again nearly ceased, to reappear in March and April. Of late the disorder has appeared in the south-west parts of Bengal, visiting severely Midnapore and Cuttack, which it almost spared in the early parts of its course. * * * A notion was entertained that there was something in the vicinity of the Soobanreeka river, connected with and immediately leading to its rise. But this was quite a mistake, for it was learnt upon inquiry, that the several divisions got the disorder equally readily in different parts of Cuttack, and that it always broke out after a fall of rain, or other manifestly strong exciting cause." It was in this neighbourhood also that the two severe visitations of armies by cholera in 1781 and 1790 happened; and on another occasion, Mr. Jameson remarks, that this tract (the northern Circars) was particularly obnoxious to the disease. And he mentions an instance of a vessel having cholera at Madras, and after getting rid of it, sailing up close to the Coromandel coast, still in health until she arrived off Ganjam. There,

Dr. Hardie, in a paper read before the Medical and Physical Society of Calcutta, in October, 1829, states, that the disease had continued to recur with violence for three years back in Ajmere and Jeypore, that the term of its appearance was towards the end of the hot winds (and commencement of the rains), and it was of rare occurrence at any other period of the year. It is stated by the natives uniformly to disappear after the rains have freely set in, and the atmosphere becomes cool and agreeable. And in a paper read before the same society in September, 1828, Mr. Mitchelson gives an account of a severe prevalence of the epidemic in Almorah in the preceding May and June; stating that the thermometer ranged from 80° to 86° in these months, whilst its ordinary range at that time of the year was from 74° to 80°; that it was during this increased heat that cholera first showed itself, advancing from the villages on the east to Almorah, where it raged for fifteen days with great fatality. "A heavy fall of rain, lasting two days, reduced the temperature, and happily diminished the effects of the disorder." Numerous other instances are continually met with of the recurrence of the epidemic in the upper provinces of Bengal, from March to June inclusive; and the ingenious Dr. Tytler, in his account of the climate of Allahabad, states, that the chief characteristics of the hot season there are hot winds, excessive dryness, and violent storms; thermometer from 85° to 112° or 120°. Another observer, in Tirhoot, a province

while at a distance of fifteen miles from the shore, during the blowing of a cold, damp, land wind, the disease suddenly reappeared. Dr. Strange states, that the vessel to which he belonged had been "at anchor nearly two months after her arrival in India, four miles off Sangor island (notorious for fevers), without cholera as long as the south-west wind blew, but on its changing to east, so as to blow on them from the land, accompanied with a raw disagreeable fog, the epidemic broke out in the crew" (Lancet, No. ccccxvi). Hence there is a probability that miasmata, conducing to the production of the disease, may be conveyed a considerable distance. In the former instance there is no want of evidence of the presence also of contagion.

bordering on Nepaul, thus describes these storms. "The greatest changes which take place in the atmosphere are during the hot weather and commencement of the rains; at those seasons Tirhoot is subject to sudden and terrific storms. During an oppressive hot day, with the thermometer at 96° or 98°, black heavy clouds rapidly form in the horizon, and in an hour or two they advance so as to overspread the whole sky, and all at once pour down a tremendous hurricane —wind, thunder, lightning, rain, and in the beginning of the hot weather also hailstones, some of which are almost as large as a hen's egg. By these the temperature is reduced in a quarter of an hour 15° or 20°." He observes, that exposure to these storms is often followed by fever, and relates an instance of a fatal attack of paralysis occurring during one of them.—*Transactions of the Medical and Physical Society of Calcutta.*

In the Asiatic Journal many accounts occur of reappearances of the epidemic, in Calcutta and various parts of Bengal, in the hot seasons of late years. In June 1827, it is stated to have been prevailing generally in India for two months. In Bundlecund it was very prevalent during the latter period of the hot winds, was checked by the rains, and in July wholly disappeared. The breaking up of the monsoon (September or October) seems also to be occasionally attended by its revivals. In 1825, a great drought and heat takes place in the middle of the rainy season, attended by great prevalence of the disease in many parts of Bengal, and it ceases after heavy rains in September. Bishop Heber mentions the cholera prevailing severely at Calcutta in April, 1824, and that the weather was intensely hot, with frequent thunder-storms, and afterwards like a close rainy autumn in England.

At Bombay too, many facts are recorded, equally instructive, of the habitudes of the epidemic. Here also we find its revivals taking place at the very same time of the year. Dr. Kennedy states, that "Surat was free from the disease

during the cold months, from October 1818 to February 1819; but it returned in the heats of March and April." Again, he states, that during the heats of April and May 1825, and in the very same months of 1826, it was prevailing in that district to a most violent degree, particularly during the Ramazan (great Moorish festival) of the latter year.

The Bombay Courier of 24th April 1819, states that a great renewal of the disease had taken place there in that month. Again, April 12, 1820, it states: "The weather for the time of the year has been very unseasonable. Strong southerly winds have prevailed, and several violent squalls of wind with heavy rain have been experienced * * Some cases of cholera have lately occurred. On the 10th of May, it is stated that the disease had prevailed with excessive violence, and that it had been necessary to re-establish the medical depots through the island. On the 21st of June, it states that the rain had fallen in torrents, and "as we conjectured it had had a beneficial effect on the epidemic." On the 10th of July, the excessive fall had continued, but the weather was clearing up. The disease had then nearly ceased. An earthquake occurred at Kaira, in that quarter, in April, and at the same time the disease reappeared at Mulligaum and Jaulna, and in May and June it is stated to have been prevailing generally in the southern Mahratta territory, destroying 12,000 persons at Colapoor. I am further particularly informed by an observer in that part of India, that the epidemic has up to the present time continued to recur almost regularly at Bombay and various neighbouring stations, about the height of the hot season, shortly before the setting-in of the rains, and to prevail until they had fallen freely. So evident is the fact, that the period is commonly known by the name of the Cholera Season.—Can it still be maintained, that the visible atmospheric conditions have not a most marked influence on the disease?

I have already stated that the disease appeared at the Mauritius at the period when the annual rains usually set in; and on more particular inquiry I find that coincidence abun-

dantly striking. In a report of Mr. Milligan of the 82d regiment, in the office of the Army Medical Board, it is stated, that "the weather on the island had been remarkably fine in the latter end of September, the whole of October, and the beginning of November. The rains commenced in the last week of November, about which time the epidemic cholera appeared among the blacks. Reliefs of troops sent into the districts arrived on the 1st of December, after two severe days' march in the rains, and soon began to suffer from its baneful effects. The disorder commenced with heavy rains after intense heat." The Topaze arrived and landed her sick about three weeks before the disorder broke out. It is probable that the contagion laid dormant for that time, being unable to take effect till a state of the atmosphere highly favourable to it was developed. It spread to Bombon in January, and Madagascar in March, thus, as in India, involving those countries when the sun was near their zenith.

In the Madras Reports too, a great mass of evidence to the same effect might be collected; but these notices have already extended to such a length, that I must be content with a very brief notice of a few of those facts. Mr. Scot states, that slight reappearances of the disease have taken place at Madras, in the hot months of 1819-20-21, but their connection with atmospherical disturbances, it appears, is not here evident. Their coincidence with the setting-in of the southerly winds has however been again observed. It is particularly noticed by Mr. Goldingham, astronomer to Government, in his Gazette, in the end of February 1820, and I distinctly observed it again in the same month of 1821; and in May 1822, the 34th regiment experienced a severe return of the disease in camp near Madras, evidently connected with a sudden change in the weather. Mr. Searle reports a return of the epidemic in January 1821 at Chicacole, and that it had been attended by a sensible change in the weather, from whence he inferred that the cause might

be a change in the electrical state of the air. And in his separate work he states, that he has found "cholera most prevalent in wet, cloudy, and oppressive weather, such as usually precedes the setting-in of the monsoon*." The disease also reappeared at Masulipatam on the 4th of June, 1822, and the superintending surgeon of the district reports, that "the weather had been intensely hot all May, and that in the early part of June there were sudden vicissitudes, thunder-storms and abundance of rain."

Mr. Mitchell observes: "In the case of sloughing ulcers, both in Ceylon and at Palamcotta, I have noticed that in close and sultry weather, and also *before* falls of rain, they are much aggravated and extend rapidly; and it struck me forcibly, that the days on which the cholera was most virulent maintained the same aspect; there was much close and sultry weather, and the sun was obscured by whitish clouds nearly the whole day †."

A remarkable instance occurs at page 195 of the work, of excessive heat, exposure to contagion, and a violent atmospheric change, combining to produce a general attack of the disease. A detachment was marching in Travancore, having experienced a great increase of temperature before their arrival at Nagracoil, but free from the epidemic. On reaching that place, they found that the disease had broken out among the inhabitants four days before. Halting there on

* P. 42.

† P. 141. Mr. Marshall observes (in his work on Ceylon, p. 39, 210) that malignant ulcers began to prevail among the troops in Ceylon in March 1818, "about the same period when fevers became more prevalent than they had been." He also observes in another place, that "*partial* showers succeeding a long period of dry weather are stated by the natives to aggravate the cause of fever." The very same observation has also been made in the West Indies. The phagedenic ulcer is also prevalent in the malarious climate of Penang and Malacca; and Dr. Ward attributes it to "meteorological peculiarities analogous to those concerned in the production of fever," which he states to prevail chiefly in the rainy monsoons.—*Medical Topography of Mulacca, &c.*

the following day, they experienced a heavy squall, preceded by oppressive heat, and followed by torrents of rain, after which the heated earth exhaled the moisture in visible steam. During that night the first cases occurred, which were followed by many others. And the observer (Mr. Provan) infers, "that these changes had most probably conspired to give energy to the effluvia or contagious matter of the disease."

This is one of the many instances which have been adduced of a great and sudden atmospherical convulsion marking, we may almost say, the instant when the epidemic starts into existence or revives; for the first cases occurring within a few hours afterwards, it is reasonable to conclude that in some instances the morbid action had begun at the very time of the occurrence. They prove almost to demonstration, that one great cause of the disease consists in a state of the atmosphere, whose presence is thus indicated. Mr. Jameson has been fully convinced of this fact; and, with many others, attributes it to the vicissitudes of temperature and moisture thus arising; but in a vast number of instances it is found that the variations of temperature attending the atmospherical disturbances and the disease have been trifling — not more than 10° of Fahrenheit; and, what is still more to the purpose, the first cases have been found to *precede* the fall of rain or the storm. Thus it was with the 34th regiment. The horrors of the day on which they suffered so severely from the epidemic, and, except a case or two, the first of its prevalence, were heightened to an extraordinary degree by a violent thunder-storm which happened in the evening*. I have

* I well remember the intense interest excited by such a combination of circumstances on another occasion. The night of the day in which the disease appeared in a party of troops under my charge was marked by a thunder-storm. The anxiety and fatigue attendant on the occurrence, with perhaps a shade of personal apprehension, which the stoutest heart might be allowed to feel on such an occasion, were to be borne amidst that war of the elements, from which we were separated only by a few folds of cotton cloth; and, as if to add a climax to

myself distinctly seen the first attacks occur on the sudden breaking up of fine weather, whilst the clouds, whose contents were about to cool the atmosphere and deluge the earth, were lowering, *but before they burst* *.

In what then but the change in the electrical state of the atmosphere, which so constantly attends these occurrences, and precedes their development, can the deleterious element of the general change consist? We distinctly feel that there is some injurious agent operating on our frames on such occasions, as before a thunder-storm; and though we may not yet be able to show on any sufficient evidence, the manner in which it acts, there is reason to believe, from the experiments of Dr. Prout, that it immediately affects that all-important function, the change of the blood in the lungs; for, as it has been already observed, he found a remarkable increase of the quantity of carbonic acid expired attending a similar state of the atmosphere. The disorder of this function in cholera is so striking and evident, that it has been continually referred to

the scene, a flock of jackals kept howling, or rather wailing in their ordinary manner, all night round the camp; emitting in infinite variety of chorus, sounds closely resembling those of human beings in distress. It required no great stretch of the imagination to fancy for a moment, that they were the voice of the hydra-headed demon of the pestilence, mocking the sufferings of his victims!

* The following instance of the production of sporadic cholera (doubtless in a subject highly predisposed to it) from this state of the atmosphere, is very striking.

"Divers instances of Peculiarities of Nature, both in Man and Brutes, communicated by Dr. Nathanael Fairfax.

"4th. Mrs. Raymund of Stow Market, when ever she hears *Thunder*, even a farr off, begins to have a bodily distemper seize her. She growes faint, sick in her stomach, and ready to vomit. At the very coming over of it, she falls into a right down Cholera, and continues under a *Vomiting* and *Looseness*, as long as the Tempest holds, and that in a more violent way, than is commonly procured by such Medicaments as are usually exhibited for those very purposes. And thus it hath been with this Gentlewoman from a Girle."

Philosophical Transactions, vol. ii, p. 550, for anno 1667.

by inquirers as the origin of the disease, and no other explanation of it bears any probability. Being then so far advanced in the elucidation of the causes and nature of the disease, it may well be hoped that the remaining links of the process will not be suffered to remain much longer in obscurity. I will conclude this part of the subject with some brief notices of the support which this explanation of the great atmospheric cause of the epidemic receives from the opinions of others. The following extracts from Mr. Forster's ingenious and valuable treatise on Meteorology (1823), exhibit a remarkable coincidence with the views contained in the original part of this work.

"That the lunar influence which I have described, exercises its power over the animal machine, by some changes effected in it by the electricity of the atmosphere, is to me more than probable. Occasionally I have observed that similar headachs, shiverings, and other nervous disorders, which occur about the time of the novilunar and plenilunar changes, also happened at other times, when from the occurrence of thunder-storms, and other the like phenomena, the electricity of the air is disturbed. It may be observed, that the approach of storms, particularly those which are highly electrified, is generally anticipated by certain nervous people by the occurrence of those nervous disorders to which they are predisposed; a particular kind of headach, occurring in the forehead, but distinguished from a headach of indigestion, by its taking place even during a cathartic operation, affords a familiar proof of my observation. These cephalalgias begin by slight symptoms, observe a climax, and then rapidly decline. The period of their greatest exacerbation, though commonly about three in the afternoon, yet sometimes varies according to the period of the electrical change in the air. I have experienced this very thing repeatedly, and have sometimes said during fine weather, that I suddenly felt certain that there existed a distant storm somewhere, not very far off, which has been afterwards proved to be true, by our

observing the scud or broken fragments of nimbus flying along in the wind. Now an electrified cloud will produce a sphere of non-electrified air around it, and beyond that throw the atmosphere into an opposite electricity. Whether the positive, the negative, or the non-electrified portion of air produces the headach, is as yet undiscovered."

Again he states: "It appears to me that it is not the heat, nor cold, nor dampness, nor drought of the air, which is chiefly concerned in producing disorders, nor the sudden transition from one to another of those states; but that it is some inexplicable peculiarity in its electric state, as I have before hinted at in section the seventh. The pain felt in limbs which have been formerly broken, previous to a change of weather, and the disturbed states of the stomachs of many persons before and during thunder-storms, are sufficient, I think, to warrant such a conjecture.

"During what has been denominated unhealthy weather, when medical practitioners have spoken of the general ill health of their patients, I have remarked circumstances which appeared to denote an irregular distribution of the atmospheric electricity. The manner of the distribution, and the continual multiform changes of the curl-cloud, ramifying about and extending its fibres in every direction; the rapid formation and subsidence of the sonder-cloud and the wane-cloud in different places, and the irregular appearance of the compound modifications; the intermitted action of De Luc's aërial electroscrope; strong and varying winds, and the abundance of luminous meteors by night, are the circumstances to which I allude. A kind of weather too, which appears to be remarkably unwholesome, is characterized by all the clouds having confused indefinite edges. * * * An easterly wind makes most people feel uncomfortable, and produces headachs in persons who are subject to them. Similar changes have most violent effects when they happen about new or full moon. * * * The atmospherical peculiarities which influence our health, may act by depriving persons already weak of a

portion of their electricity, and thus the energies of the brain and nervous system may be diminished; or the atmospherical electricity, being unequally distributed in the air, or propagated downward at intervals, it may occasion an irregular distribution of it in our bodies, and produce an irregularity of function." — Page 164—178.

Mr. Annesley has adopted and maintained the opinion (without acknowledgment), that a change in the electricity of the atmosphere has been one of the great causes of the disease, and adduces the disturbances of the order of the seasons and heavy rains attending the epidemic in support of it. Mr. Bell, in his treatise on the same subject, considers it probable that some change in the electricity of the surface of the earth is the cause; and Dr. Ainslie ably supports the opinion, that some electric or galvanic agency existing in the atmosphere, actually produces the disease. Mr. Searle also, in his treatise on cholera (1831), says: "This atmospheric agency or modifying cause I believe, however, to be (without attempting to define its nature, though I think it probably dependent upon a negative condition or peculiar electrical state of the earth or air), in character, one simply of depressive influence." M. Moreau de Jonnès, in his elaborate Report of 1831 (p. 109) observes: "Des observateurs distinguès, témoins des ravages du choléra pestilentiel, ont été frappés si vivement de l'etonnante rapidité de ses effets meurtriers, qu'ils ont cru pouvoir les attribuer à quelque modification dans l'action du fluide electrique. Le respectable docteur Loder, médecin de l'empereur a Moscou pendant l'irruption de la maladie en cette capitale, a donné à cette conjecture le soutein de son autorité." And Mr. Millingen in his "Observations sur le Choléra Morbus," &c. (Paris, 1831), adduces various arguments in favour of the same opinion, and proposes galvanism as a means of cure.

Moreover, Dr. James Curry has publicly expressed his opinion, that the prevalence of plague was connected with atmospherical electricity; and Dr. Smith, in his distinguished work

on "the Etiology and Philosophy of Epidemics*," arrives at the conclusion, that that occult disordered state of the atmosphere, which has always been looked on as the great primary cause of the principal epidemics, and which he terms *epidemic meteoration*, "probably arises principally from variations in the quantity of its electricity." Dr. Johnson adds, in his review of the work: "The influenza—the cholera of India — the English sweating sickness — are notorious examples of the effects of epidemic meteoration." However "insensible," and "hidden," and inscrutable this meteoration may have been in former times and in other countries, it has been as sensible and evident in India as the light of its vertical sun; and it appears to me, that it requires nothing short of a mental amaurosis to deny its immense influence in producing and promoting the prevalence of the epidemic cholera.

* New York, 1824.

SECTION III.

OF THE INFLUENCE OF MARCHING OR TRAVELLING IN PRODUCING THE DISEASE.

PROPOSITION VIII. Troops on their march from station to station, or in the field, and persons travelling in India, are particularly subject to the disease.

WE are indebted for the establishment of this remarkable fact to the observers of the Madras Presidency, and particularly to Mr. Scot, for it does not appear to have excited any marked attention, or at least to have been publicly noticed, in the other two divisions of India. Mr. Scot in various places mentions the greater prevalence of the disease in corps on their march, than in stationary bodies of people. Thus at page 38, he observes: "It seems to be certain that a corps under march must run a greater risk of being attacked with cholera than a corps in quarters." And in 1821, he states, that the disease could no longer be considered epidemic on the Establishment, except at some particular places, and in the camps of marching corps. In the following year he finds that it had nearly disappeared, with the same exceptions. The same observations have been extensively made by other medical officers on the peninsula. Mr. Chalmers states, that "travellers seem on all occasions to be more obnoxious to its attacks than residents, and seem capable of carrying with them to a considerable distance a sort of infected cholera

atmosphere, which is at all times liable to affect them or those near them." Mr. Wight observes, in 1822, that the epidemic had almost invariably attacked any body of men that had made a march of any distance. Dr. Scott and Dr. Fasken also remark numerous cases occurring in individuals on arriving from journeys, as well as in moving bodies of people; and in a report of my own in 1822, it is stated, that "one of the most striking and best established facts regarding the causes of the disease, is, that troops are more subject to it in camp than in quarters, as it appears that bodies of men have rarely moved in the country of late years without suffering from it*." The numerous instances already mentioned, as stated by Mr. Scot, of attacks in marching corps, may also be cited in support of this position.

These statements are abundantly sufficient to show the increased prevalence of the disease arising from marching or travelling, but they give no idea of the dreadful extent to which this simple and apparently harmless circumstance is capable of operating to the destruction of human life. In the years 1819, 1820, 1821, after the disease had overspread the country, and, with respect to the stationary inhabitants, in a great measure exhausted its violence, even when it had "ceased to be epidemic" in general, we find the most violent attacks which the Madras troops ever suffered occurring in marching corps. In thirty-one of the thirty-four instances of these attacks which Mr. Scot mentions (being all those in which the number of cases and deaths are stated), the total of the former is 3,636, being on the average one hundred and seven to each corps of from eight hundred to one thousand strong, and these in the sepoys alone; the sufferings of the numerous camp-followers, who are always more obnoxious to the disease than the troops, must have been immense. This is a much greater proportion than has commonly occurred

* P. 121.

among stationary bodies of people, even in the first spread of the epidemic; for instance, it is calculated by Mr. Ogilvy, in the Bombay Reports, that of the population of that city (210,000) only 7½ per cent. were attacked. And not only were the attacks in these corps thus numerous, but far beyond the usual average in mortality. Mr. Scot finds that the total number of cases occurring in the Madras troops in 1818 and the four succeeding years, is 19,494, and the deaths 4,430, giving a proportion of 22½ per cent. But the deaths in the thirty-one marching corps are 1,329, and therefore their proportion to the cases (3,636) is no less than 36½ per cent. And if we deduct the attacks and deaths in these corps from those of the whole army, the remaining proportionate mortality is reduced to below 20 per cent. Moreover, these are far from being the whole of the attacks which have happened on the establishment in corps marching. Mr. Scot states, that the information he possessed concerning these attacks up to the middle of 1820 was very defective, "therefore not many instances prior to that period could be given." It is probable, therefore, that if the whole of these visitations could be separated, the rate of mortality in the stationary troops would be found very low. In one corps alone, not included with the above thirty-one (as the number of attacks was not known), the deaths of sepoys amounted to 173, probably one-fifth of their total number!

These circumstances, occurring in the later years of the prevalence of the epidemic, explain to us some surprising facts observed at its first out-pouring over India, regarding the different manner in which it affected different corps, which were then quite inexplicable. Thus at Nagpour, in May 1818, the disease had been prevailing a fortnight among the inhabitants of the city, and had begun to show itself, but in a very slight degree, among the troops at the station, when a large force arrived from a siege, and was stationed there. Immediately it fell upon the new comers, like the samiel of the desert, and upon them alone. For several days it raged

with extreme violence among them, whilst the rest of the troops, consisting of one or more corps and various detachments, remained almost free from it, and they never suffered but in a trifling degree. One of these corps had two companies with the beseiging force; they returned with it and rejoined their corps. Though they were mixed up with the rest of the corps, they suffered in an equal degree with the rest of the field-force, whilst the other companies of the corps were scarcely affected. On the day after their arrival, sixteen cases occurred in these two companies, and none in the rest. About the same time it broke out with the same rapidity and violence, in a portion of the force returning from the field, left at Hingumghaut, fifty miles south of Nagpour, whilst another corps, stationed only forty miles from Hingumghaut, was attacked shortly after and suffered but very slightly*.

Thus also it happened with the 34th and 84th regiments. They had been stationed together at Bellary for some time, when the former marched for Bangalore, on the 17th of September, 1818. It had scarcely left the station when the cholera appeared in the 84th regiment, but in a moderate degree, and somewhat gradual manner, twenty-nine cases and eight deaths only occurring by the end of the month, when it was nearly exhausted. But with the 34th regiment, as already shown, the attack was very sudden, and between the 21st and end of the month, ninety-one men were attacked and thirty-seven died, out of a strength of about seven hundred. It is probable, however, that the violent atmospherical disturbances accompanying this attack (greater apparently than at Bellary) contributed to make this difference. A native corps returned from Ceylon to Palamcotta, when the disease was spreading over that district. For a considerable time it was confined to that corps, though they held free intercourse with the inhabitants, and they continued to suffer

* Madras Report, 66—68.

from it for a month after it had left the fixed population*. To the same cause we must in a great measure attribute that most violent and insulated attack occurring in the Marquis of Hastings's force, in November, 1817. The force was at the time engaged in active operations against the Pindarees—that army of banditti, who with the connivance and assistance of our allies, the Mahratta powers, ravaged a great part of the British possessions in India. Dr. Kennedy, in his treatise on cholera, relates that he was at Surat when a native corps left that station, in November, 1819. They were in high health, having had a few slight cases of cholera in October, but before the march they had all disappeared. He followed them a few days after on the route to Baroda, a distance of eighty miles; and hearing nothing of cholera on the way, he was astonished on arriving there to find the corps suffering from it in its worst form, their casualties being from eight to fifteen daily. "The weather was cool and pleasant. There was really nothing to which, by ever so far-fetched a reasoning, we could ascribe the situation of these poor people. The rest of the cantonment enjoyed perfect health, though breathing the same atmosphere, drinking water from the same wells, and procuring provisions from the same bazaar, whilst the most unrestrained intercourse existed between the infected battalion and the other two healthy battalions of the station. The city of Baroda and its suburbs were reported to be unaffected; nor have I ever learnt that the disease then existed in the adjacent villages; and yet this solitary insulated body of hardy soldiery, in all the vigour of manhood and exciting preparations for field-service, encamped upon a dry and open spot of as healthy ground as any in the neighbourhood, within the lines of a populous cantonment, and only a mile distant from one of the largest cities in India, seemed devoted alone to "the pestilence that walked in darkness, and the destruction that wasted at noon-

* This, however, may have been owing to their having probably suffered from fever in the malarious climate of Ceylon.

day," without any assignable cause, but that the seeds of the disease might have been sown in their constitution during the month of October, at Surat. Finally, the pestilence ceased as inexplicably as it had commenced, after having in less than three weeks nearly decimated the battalion*." But on the facts I have stated, showing the influence of marching, the explanation is perfectly obvious. The wonder indeed remains, that so great an effect should arise from a cause apparently so trifling;—but the whole history of this epidemic is a tissue of wonders! Of this take another example. In March 1821, two companies of another native corps arrived at Baroda, suffering from the epidemic, which had attacked them at a village on their route two days before, where it existed in a trifling degree. Ten or twelve days after them arrived the remainder of the corps, equally suffering from the disease, which had attacked them at the same place that it did the detachment. This battalion was also decimated in a short time, and, as before, they were the sole sufferers. "The officers and troops stationed in the province were as healthy as usual, and those at Baroda looked with astonishment as well as deep concern, on the sufferings of their newly-arrived comrades. The disease was not prevailing, nor did it spread beyond the new comers, and with them it seemed to cease, before their constitutions could have been expected to assimilate to the local climate or contagion." Moreover, a small party of the same corps, landing for refreshment about the same time from a small vessel on the neighbouring coast, took up their abode in a grove near a village, with of course every disposition to enjoyment which the situation would give rise to. Here the disease broke out among them, and in a few days more than two-thirds of the party were destroyed by it†! In these instances, a high susceptibility to the disease from other causes than marching is to be taken into account. A part of the corps had just returned from the Persian Gulf,

* P. 12.

† Dr. Kennedy, without examining the question, wholly discountenances the idea of aërial electricity producing the epidemic, and "would

and in all probability had not before experienced the disease; the rest of the corps came from a healthy station on the coast near Goa. The district they entered is very subject to fevers*. But in the instance of the former corps there were no such circumstances to account for the attack; Surat is as subject to fevers as Baroda.

Mr. Jameson remarks, that the left division of the Bengal army had suffered from the disease in an extraordinary manner, and attributes it to their having been long marching and suffering great fatigue. He also states, that the silk-weavers in Bengal, who were regularly employed in light tasks, suffered very little, whilst coolies, and all classes casually bearing burthens or going long journeys, were frequent victims. M. Moreau de Jonnès observes: "Il parait que l'hiver 1826 a 1827 *manqua cette fois d'excercer sa benigne influence et d'engourdir le germe de la contagion.* Le 25 Janvier le 59 reg. etant parti du Fort William, fut atteint *pendant sa marche* par le cholera, qui lui tua 15 hommes."

To the same cause likewise is to be attributed the circumstance so often observed, of the great assemblages of pilgrims at the numerous celebrated shrines in India suffering so excessively from the epidemic. So it was at Hurdwar in April 1783, when the disease is said to have swept off twenty thousand pilgrims, and yet to have been confined to that congregation, for it extended not seven miles from the place. In like manner severe visitations took place at Punderpoor, and at Tripetty in 1818, at the great fair of Beejnuggur in 1819, and at the pearl fishery in the gulf of Manaar in 1822, where a great assemblage of people took place from various parts of India. The British missionaries give accounts of similar fatality attending the great festival of Juggernaut, par-

cut short such inquiries by the question of *cui bono?*" If there is a "jargon of philosophy abroad," it is fairly opposed by the jargon of anti-philosophy. But it is surprising that the ability which is so conspicuous in Dr. Kennedy's work (and which I hear is well known on the Bombay side of India) should ever be employed in advocating such sentiments.

* Ibid. p. 15.

ticularly in 1821-25-29. The scenes presented on these occasions are described as most awful, numbers of expiring persons being carried into the temples to breathe their last before the idols. One of these gentlemen counted three hundred unburied bodies by the road-side, in a distance of five miles, with the birds of prey devouring them (*Asiatic Journal*). Thus also we find that in the numerous festivals of the Hindoos at every town, when they spend great part of their time, night and day, in marching up and down in processions, and excite themselves almost to madness; and in the Mohorrum (Beyram or Ramzan) of the Mussulmen*, when similar customs prevail, and in addition, they exhaust themselves by fasting as long as the sun is above the horizon —under these circumstances we continually find the pestilence reaping a rich harvest of victims; for whenever a native feast took place during the prevalence of the epidemic, it was observed to be attended by an exacerbation of it. On the appearance of the disease at the great cities, similar ceremonies have generally been gone through, by the Hindoos particularly, to avert the wrath of the Deity, and thus they increase the evil by the very means to which they resort for its removal†.

Even some of our own customs, though of a very different nature, seem to be productive of the same effects, and by the very same mode of operation. It is related, that on a ball being given on board the ship Liverpool, in the Hoogly, in 1819, of fifty persons present at it, one-half were seized with cholera, and ten died within a week afterwards! It would appear that the principal cause was not any thing particularly connected with the vessel itself, as the captain and surgeon of the ship were among the victims.

* "Avicenna remarks the particular prevalence of cholera in the month of Ramzan."—*Bengal Report.*

† The following extract from a native newspaper published in Calcutta, will give some idea of the nature of these ceremonies, and of the abject superstition, fostered by priestcraft, of the Hindoos.

"Jeypore. The hurkarus reported that the cholera prevailed in the

I have already mentioned the notices which Mr. Scot has given of thirty-four epidemical attacks in marching corps, and twenty-six instances of corps making marches without encountering the disease. These insulated moving bodies are admirably adapted to elucidating the causes of the epidemic; and if we had a knowledge of all the circumstances attending these sixty cases, we should probably possess data on which the merest tyro might solve this long-tried problem. These might be comprised in a small and simple table for each, showing the daily temperature and meteorological phenomena —the daily number of fresh cases of the disease—whether contagion existed in it on setting off, and its absence or presence in the inhabitants of each halting place on the route—the nature of the country at each halting place—and also the facts relating to the previous general susceptibility of the corps, as whether it had lately undergone the disease, was healthy, or enfeebled by other preceding diseases, &c. Far different is the actual state of our information on these points. In only fifteen of these instances of corps which suffered, is the accompanying state of the weather at all noticed, and in

city to an alarming extent, and a hundred people a day died of the disease. On the 2d of April the band of state commenced playing, and the astrologers and singers attended. On the 3d the hurkarus reported that a rite had been performed to rid the city of cholera. A brahman, after lighting a row of lamps, containing a maund and ten seers of oil, took four goats, and driving them about in different directions, cut the throat of one without the Red-bridge gate, of another at the Motikatreh, and the third at the burying ground; whence, coming to the gate of the palace, he lighted a wisp of straw, and ran with it to the Chaudpul gate, where he killed the fourth goat. He then returned to Krishu Kund, and drew some water from the well in his brass pot, over which having muttered a charm, he sprinkled some of it upon the wall, from which simultaneously issued four snakes, who fled *towards the west*. Upon their departure the brahman said, 'these are the spirits of pestilence, who, in the shape of serpents, have infested our city, and who are now expelled; to prevent their return, let the people repair on Wednesday to the temple of Haunman without the Chaudpul gate.'"

but one of the escapes. On the other points still less information is given. But the facts which appear, few and casual as they are, seem to throw considerable light on the subject. I will therefore briefly notice them, in the order in which they stand in Mr. Scot's valuable narrative.

The 8th regiment were attacked on the bank of a little river, which was so swollen as to detain them for a day. A party of three hundred and fifty Europeans, a few days after, marching from Madras to the northward, experienced a tremendous hurricane on the 9th and 10th of May, 1820, against which no tent could stand for a moment; nevertheless they continued healthy until the 18th, when they reached Cuddapa, and encamped on the ground just left by the other corps just mentioned, with some of their men dead of cholera lying on it still unburied. On the 19th the disease appeared in them, and immediately after became very prevalent. Mr. Scot particularly notices their not being attacked on the occurrence of the storm; the reason doubtless is, that the *sine qua non*, contagion, was not then present. But I have proof that that very storm actually was the exciting cause of the disease in another party. Captain Drew of the 17th N. I. informed me, that he was marching in Mysore when he encountered that storm on the 9th, and that the cholera made its appearance in his party the same night, and prevailed severely for several days. Shortly afterwards the party rejoined their corps, also on its march, at Seringapatam. The corps had till then been free from the disease, but from that time a few straggling cases occurred in it. There was then nothing remarkable in the weather, but on their arrival at Serah on the 1st of June, they experienced another violent storm, with a deluge of rain, and on the following day about fifty cases occurred in the sepoys: that the corps lost nearly one hundred sepoys and four hundred camp followers on the short march from thence to Bellary, the rain continuing to fall in great quantities. This corps is one of those contained in Mr. Scot's detail, but without any mention of the weather or the infected detachment. These facts are equally indicative of atmospheric

influence and contagion. The gentleman from whom I obtained them had no preconceived opinions to support, and my own, at the time that his statement was noted down, though favourable to the former were adverse to the latter.

The 22d regiment had marched twenty days, with variable squally weather, when they reached Colar, where they were attacked with the epidemic. The weather was chilly and damp, with thick clouds, when the disease appeared. The situation of Colar is thus described. "The town is overhung by large and high hills to the north-west; it is open to the east, but closely surrounded by large tanks, rice fields, and so much wood, that room could scarcely be found for encampment." We shall subsequently see that rice-cultivation has appeared to be one of the great local causes of the epidemic*.

The weather was very boisterous and rainy whilst the disease prevailed in the 7th regiment, N. I.; but after upwards of a month's suffering from it they recovered health, though the same weather attended them on their renewed march, and they found the disease existing on their route. A corps of cavalry marched with them, when the disease prevailed, yet suffered but very slightly. With the 22d the weather was very rainy whilst the disease prevailed, and became fine when it disappeared. The 21st regiment had very rainy weather all the early part of their march, but no cholera "until after the air had become dry, the sky serene, and the route near the sea shore." These circumstances are stated strongly by Mr. Scot, as it appears, to show the nullity of atmospheric influence; but let us look a little further into the facts of the case. In the early part of the march proba-

* It is effected by reducing the fields to perfect levels, and inundating them from rivers or tanks (artificial lakes). They are ploughed in the state of soft mud, and the rice usually *transplanted* into them. The mud is kept covered with a thin sheet of water until the grain approaches maturity, when the supply of water is withheld, and the ground is allowed to dry up. There are commonly two crops annually, but the principal one ripens early in the hot season, and the fields continue in the dry state till the rains.

bly the predisposition to the disease arising from the march was not fully formed, or contagion may not have existed. When the disease attacked them, they had reached the sea-face of the zilla of Nellore, which is particularized by Mr. Sutton in his detailed report on the prevalence of the epidemic in that district, as having suffered most severely during both visits of the disease; and the explanation is to be found in his remark, that on that side of the zilla a great deal of rice-cultivation is carried on*. And Mr. Scot himself states this route to be one of those which were particularly obnoxious to cholera†. In the neighbouring district of Guntoor it is stated that the villages which were situated near tanks (and consequently rice-fields) had suffered most‡.

In the 20th regiment, when this disease appeared, the weather was cool and cloudy, with rain every evening. In the 1st battalion 1st regiment, the weather was cool, with very little rain. The disease is attributed to eating new unripe grain. The 46th regiment was healthy on their march, until they experienced, one night, a violent storm of wind and rain; the next day six cases appeared in the soldiers, and five or six more in the camp-followers; after which there was no further appearance of the disease. The 8th regiment was attacked whilst encamped on low ground near a tank, with the thermometer at 115°. Whilst suffering from the disease, a party of artillery in health one day took up the ground of encampment they had just left, with several of their unburied dead on it. That party was attacked the same day§. The 2d battalion 1st regiment, was attacked when encamped in a recess among hills, near a tank. The weather is stated to have been "generally good, the sky clear, the days hot, and the night cool." On "two successive days there were thunder-storms with wind and rain, and on these days the number of attacks was greater than for some time before." The disease was also observed to prevail with particular severity at the time of new moon. It afterwards abated, but just before the ensuing full moon resumed its virulence, and

* P. 38. † P. 22. ‡ P 42. § P. 48.

for a few days more raged as severely as ever *. Two hundred and eighty-three sepoys, probably much more than one-fourth of their total number, were attacked.

The 4th regiment was attacked during excessive heat. A fall of rain took place a week afterwards, after which the disease began to abate, and in a fortnight more ceased; and the corps made the rest of a long march in the rainy season without any return of it. With the 6th regiment the weather was exceedingly hot and dry during the first half of the prevalency, in the latter part cool and rainy. With the 24th the weather was "delightful" when the disease prevailed. The 2d regiment suffered during the rainy season, and in a tract of country where cholera was prevailing. In the 53d regiment the disease commenced with a case a day for four days. On the third day they experienced a great increase of temperature on descending from the Mysore into the Carnatic, and the same day a thunder-storm, so violent that the wind threw down their tents, and after the next day the disorder progressively increased. These are all the notices of the states of the weather which occur during these attacks.

Many more instructive facts might be gleaned from the cir-

* Mr. Connel, staff-surgeon of Hydrabad, also reports, that he has observed the disease to be most prevalent at new and full moon, and that the natives had themselves made the same observation. It is not, however, my intention, at least at present, to resume the subject. Mr. Scot has collected a great number of facts regarding it, from whence he infers, that this influence in the present instance has had no existence. But I must be permitted to say, that Mr. Scot appears generally to lean to the sceptical side of an argument. I have not leisure at present to examine the facts which he adduces, or the numerous others which might be collected; but so strong is the impression on my mind, from my own experience and researches, supported in so many instances by the observations of others, and by analogy, that I am confident, when the subject is sufficiently investigated, the influence of the moon on the disease will be found perfectly evident. Dr. Kennedy says, the constitution both of the native of India and the denizen is as evidently under sol-lunar influence as the ocean itself; "or, what is the same thing, under the influence of the changes of weather which accompany the changes of the planet."—*Notes on Cholera*, p. 129.

cumstances of these cases, but already this detail has extended to too great a length. A few further observations of a more general nature may however be permitted. The marches were all of considerable length, from one to five months. In general, the disease was far from prevailing through the whole march. Often the corps has set off with it prevailing to a slight degree, or it has appeared in the beginning in a straggling manner, and has so gone on for some time, until all at once it started up in a violent degree: but in general, as on other occasions, like a paroxysm of disease in the predisposed individual, it had a more defined beginning, a rapid course to its crisis, and, after no long time, usually a complete end. It was generally got rid of before the end of the march, and often the remainder of a long march has been got through in health, even under unfavourable circumstances of weather, and the presence of the disease on the route. Its external causes would appear to have been still present, but the susceptibility was exhausted, and seemed even here not to be quickly reproduced. But one instance of a second attack in the same march is mentioned. The attacks however appear to be more protracted and irregular than in quarters. In various instances they have been attacked when making halts of some days. On other occasions they make long halts when attacked, either from being unable to proceed, or in hopes of thus getting rid of the disorder, without finding its prevalence materially affected by the change. Instances also have been mentioned, where the entire prevalence was after the conclusion of the march.

In many instances it is distinctly proved, that the towns and villages through which the infected corps passed were quite free from the epidemic at the time; the diseased body passing on (if they were able to move at all) in a state of the most intense general suffering, and bearing with them the seeds of further disease and death, whilst the peaceful inhabitants of the country were enjoying perfect health; — as if the hand of Providence would thus signally mark his aversion to the calling of the soldier.

It was more difficult for the observers to ascertain whether

the disease was actually conveyed to the healthy villages by the passage of the infected body; but in various instances it is clearly recorded that such was the case. Thus in the 1st and 15th and 34th regiments it is stated, that it broke out after the passage of the corps, at every village on their route through entire districts. On several other occasions it is noticed that it was not thus transferred, and that even other corps following closely in the rear of the infected corps have escaped. These circumstances are equally probable with the former; for doubtless the contagion would be conveyed or not, as it met with favouring circumstances of susceptibility, meteoric influence, and malaria, or was robbed of its sting by a serene and healthy atmosphere, and repulsed by constitutions indisposed to its reception. It is even probable, that the instances in which it thus fails to be propagated would be more numerous than the reverse; for we have seen that marching produces a high susceptibility of the disease, whilst it exists in but a very low degree in the fixed population.

The interesting question next arises, to what particular cause or causes exclusively attending the march of troops or private journeys are we to attribute this very marked effect? On this point I have to confess not having been able to arrive at any satisfactory conclusion; for if we analyze the change of life attending a march, each of its particular circumstances appears to be inadequate to the effect; and any of them that may be set up as the cause, seems to be assailable by almost unanswerable arguments.

It is indeed very surprising, that a change of life, which has so generally been observed in all countries to have a favourable effect on the human frame, should ever be thus productive of disease; and, in particular, an observer of the usual effect of marching in India on the health of troops would never have predicted that that circumstance would render them obnoxious to cholera, or indeed any other disease. It is commonly found that both officers and soldiers enjoy a high degree of health whilst marching. I have found the hospital admissions of a whole corps, from being four or five daily,

entirely suspended all the early part of a march; so that, leaving the sick behind, I have enjoyed a sinecure — a *rare* circumstance for the regimental surgeon — for a fortnight. The regular gentle exercise, the daily change of air and scene in a beautiful country, attended with constant novelty and amusement, render a march in India commonly a scene of great enjoyment, and more like a party of pleasure than the performance of a duty. The marches are made very early in the morning, and the "auroral gaiety" that so conspicuously attends them, both in officers and men, show that they are no tasks. Even the horses partake of the general hilarity and health; they prance and grow fat notwithstanding their additional labour, and being picketted in the sun often with the thermometer at 140°.

The principal circumstances of difference between troops on the march and in quarters, which appear capable of producing disease, may be stated as follows:—

1. An increase of temperature during the day, usually of 10° or 15°, arising from the change from houses into tents; and,

2. The same imperfect defence from the cold and moisture of the atmosphere.

3. A degree of labour, which to soldiers is unwonted.

4. Exposure to contagion on the route.

The sudden increase of temperature, which we know to be one of the great predisposing causes of the disease, has appeared to be the condition of which we are in search, and doubtless has had considerable share in the effect. But how very often the epidemic has appeared in marching corps when the heat, even of tents, was moderate! and did we not in the same years constantly suffer high degrees of heat, even suddenly arising, in the hot weather in quarters, without this remarkable production of cholera? It is not found that troops in standing camp thus constantly suffer from the disease.

And with regard to the atmospherical vicissitudes, and exposure to sudden cold and moisture, on which so much stress has been laid in explaining the causes of cholera,

—certainly the thermometer falls at night much lower, as well as rises higher in the day, in the tent than in the house; and very imperfect is the defence from rain and cold winds, particularly to the poor camp-follower, who has generally no other than a piece of cloth or thin blanket set up tent-wise; and these exposures, when present, must have been highly influential. But again, how often the disease has appeared in these bodies when there was little or nothing of this kind to account for it; and besides, it is not in such *exciting* causes that we can find the explanation; for, as we have seen, the disease continues to prevail long after a corps arrives in quarters, and even sometimes does not begin till after the arrival.

The distance marched each day is about ten or twelve miles, with a day's halt after every third march; no considerable labour certainly to men in the vigour of life; but to the delicately-formed sepoy (who carries his knapsack, which the European soldier usually does not) and his family, unaccustomed to labour, it may often produce that exhaustion of the frame which renders it susceptible of cholera; and this is probably the cause which has had the greatest share in the effect. But why should the disease continue to prevail long after the frame has had time to recruit itself by rest? Upon the whole it appears, that though each of these causes separately is quite inadequate to the effect, combinations of them may present circumstances sufficiently favourable for the development of a general attack; and we have seen how often contagion encountered on the march, has proved the lighted match which has immediately produced that explosion.

But "there is more in nature than our philosophy dreams of,"—much as it is addicted to dreaming. The true cause may lie deeper, yet be exceedingly simple when arrived at. Whether it is from the act of locomotion—or the change of air and scene—or the entire change of mode of life—or all together, we are sensible of a corresponding change in our frames on making an unwonted journey. There is an excitement produced—an increased intensity of action in various

functions, circulation, appetite and digestion, &c. and such an alteration in our feelings as almost to make us doubt our identity,— almost to contradict the apophthegm, "cœlum non animum mutant," &c. Dr. Prout has shown, that the chemical function of respiration is greatly influenced by various external causes, and different states of the frame; that the quantity of carbonic acid gas produced (and consequently that of oxygen consumed) is remarkably diminished by violent exercise, long abstinence, the depressing passions, alcohol, &c.; agents which are well known to be generally injurious to our frames, but increased by an opposite class — unhappily few, and less marked in their effects in other instances as well as in this — as moderate exercise and the exhilarating passions; that it is subject to great and sudden fluctuations, and when it is from any cause raised above its ordinary standard, it is afterwards consequently depressed below it. May it not then be conjectured, that the great changes in the system produced by travelling, influencing this as well as other functions, produces some change in it (probably its occasional excessive depression) which is immediately connected with the production of cholera in our frames? We cannot suppose that that most momentous process can be changed, as it is actually shown by experiment to be, without some corresponding changes in the frame, or a tendency to them — a risk of the derangement of the harmony of its functions. The discoveries of Dr. Prout and others, regarding the variations in this function, appear to be among the most important facts that have been brought to light in physiology in modern times. Whether electricity be concerned in it or not, they seem to furnish a clue to some of the great arcana of the immediate causes of disease. Messrs. Allen and Pepys have discovered, that the quantity of carbonic acid produced was less during sleep than when waking (a circumstance probably connected with the evident change in the mechanical part of the process on the occurrence of sleep); and is it not during sleep that the frame is found to be most susceptible of disease? It is well known that a vessel may lie off a malarious coast in a hot climate for

a long time, and the crew be daily employed ashore, yet shall not be affected with fever as long as they *sleep* not on shore. So also we usually bear great exposure to cold and wet without injury whilst awake; but if we sleep on the roof of a coach, or at home in wet clothes, or damp sheets, or in a draught of cold wind, we "catch cold," and a catarrh, a fever, or any other disease to which we may be predisposed, is produced. So also *it has been universally observed, that cholera generally makes its attack at night.* Such likewise is the case with the paroxysm of epilepsy; and often have I felt the cold fit of an intermittent springing out of a midday siesta.

But however indistinct may be our view of the immediate causes of this particular prevalence, the truth of the general theorem is not the less evident, that the movement of troops, and probably also their residence in stationary camp or bivouac, are a most powerful means of both reproducing and disseminating the disease. Even in the foregoing brief excerpta from the histories of the epidemic, how often have we seen the expiring embers of the disease by this means fanned into a flame in a body of men, and again dispersed by it with fatal effect over a whole line of country? These are facts for our rulers to weigh and to act upon. They clothe war with additional horrors, and exhibit its destructive influence extending far beyond its immediate sphere of action. Should this epidemic unfortunately overspread all Europe, and (what is still more to be apprehended) afterwards maintain a permanent footing in it, as it has done in India, the share which war will have in generating and fostering it, and preventing its natural dissolution or extirpation, will probably become so evident, that all thinking persons will unanimously see the necessity of avoiding or suppressing that scourge of the human race — of our own infliction, but greater than any inflicted by Providence in the form of epidemical diseases — which the progress of civilization should ere now have banished from the world.

SECTION IV.

OF THE INFLUENCE OF LOCALITIES ON THE PREVALENCE OF THE EPIDEMIC.

PROPOSITION IX. The disease shows an evident preference for the low and level parts of a country, and avoidance of more elevated tracts.

X. It is found to prevail most severely in all the moist, close, and filthy parts of any city or neighbourhood.

XI. It commonly follows the course of rivers, both navigable and unnavigable.

XII. It prevails most severely in all those countries and places, where, from the prevalence of the endemic fever, malaria is known to exist; and in such situations its epidemic duration has commonly been greatly protracted.

IT has often been remarked in the histories of other epidemics, that they have been found particularly to affect low and unhealthy situations, and that the opposite description of localities were inimical to their existence or diffusion; but never have these circumstances been so generally and distinctly observed and recorded as in the present instance. No sooner had the disease begun to emerge in every direction from the low and level territory of Bengal Proper, than it was found to spread along the lines of country similar to those in which it had its birth, and to shun the more elevated tracts which it then first encountered. Subsequently we find, as it proceeds through the upper provinces, it is repelled by the extensive

and greatly elevated plateau which runs parallel with the Ganges at the foot of the great lines of Himalaya mountains, and is in fact their lower range. And at the same time far to the westward, in Rajapootana, the same fact is evident. "In June 1818, it had got the length of Kotah, when it is said to have cut off a hundred men a day, and to have produced such dismay that the inhabitants were abandoning the city in distraction. Having, however, reached the high and mountainous tract, which has invariably been found inimical to its existence, it seems now to have died away — a proof of this is, its never having reached the states of Oudeypoor and Ajmere." In like manner Mr. Jameson traces its course from Cuttack along the Mahanuddy to the countries about the upper part of that river, and finds it but slightly affecting the contiguous mountainous tracts of Ramghur and Sirgooja. And not only were the elevated tracts and table-lands partially or wholly exempted, but the insulated mountains and hill-forts, as Khotass, Adjeghur, and Kallingur, which enjoyed an entire immunity, whilst in the plains all around, even to their very feet, the pestilence was sweeping off its tithe of victims.

Mr. Jameson finds, "there is abundant proof that in high, dry, and generally salubrious spots, it was both less frequent in its appearance, and less general and fatal in its attacks, than in those that were low and manifestly unwholesome. This indeed might have been previously concluded from a general observance of the different course pursued by it in the low and stagnating climate of Bengal, where, having once gained head, it tarried for years, and in the pure and elastic atmosphere of the upper provinces, in which it was slowly received and quickly lost. But if we trace it in its progress through different cities and tracts of country, we shall find this modification of its agency, according to difference of situation, almost invariably taking place. Jessore, the place in which the disorder first put on a very malignant form, is a crowded, dirty, ill-ventilated town, surrounded by a thick jungle, and in the rains by an immense quantity of stagnant water. Here,

accordingly, the disease did unspeakable mischief, and its ravages were not diminished until the inhabitants abandoned the city. * * * In Sylhet the influence of situation was perhaps more remarkable than in any other quarter. From the uniform result of queries sent round to the police officers of the different departments, it appeared, that the villages in which it raged most extensively, were considered by the natives as comparatively unhealthy and obnoxious to intermittent fevers, being exposed to the effluvia arising from marshes and extensive lakes in which the Zila abounds, particularly towards the south-west division, where the greatest number of victims fell. The sepoy lines, on the contrary, being placed from sixty to one hundred feet above the general level of the country, had scarcely any cases, excepting such as occurred in persons on guard at the different outposts.

"In Nuddea, high and dry places and upper-roomed houses were more free than low and marshy spots with luxuriant vegetation. In the barracks of the European regiment at Berhampore, of twenty-four casualties, seventeen took place in two companies inhabiting the lower range. This range was very damp, and had in its vicinity to the north-east an extensive swamp, from which an offensive stench proceeded. The disease showed no variety of appearance in Rajshahy, because almost every town and village are equally surrounded by ditches full of stagnant water and filth of every kind; but in Malda, only the villages lying in the flats near the river were attacked. In Bhaugulpore all the lofty open country escaped, whilst those parts most subject to fevers suffered severely. The troops and followers in the cantonment of Carringur entirely escaped, although two villages situated immediately on their boundary ditch suffered dreadfully. But the cantonments were seventy-two feet above the villages*." Numerous other facts to the same effect occur in the course of the work, and various other instances of exemption of troops,

* P. 21, 33, 106, et seq.

for which no cause is assigned, have probably arisen from the same circumstances, for high and dry situations are usually chosen for barracks.

Unhappily, however, it was found that the immunity thus arising from situation was in general only temporary. In innumerable instances these partly favoured spots and tracts of country were not long allowed to congratulate themselves on their escape. Thus in the same year that the upper provinces were ravaged, the epidemic penetrated into some of the elevated valleys of the inferior range of the Himalaya, Nepaul and Kumaoon, and in the following year into those more northerly ones of Almora and Deyra Dhoon. But it proceeded no farther in this direction. The stupendous Himalaya (visible at a distance of two hundred and forty miles) proved a barrier which it was never able to pass; and thus the northern parts of Asia were, for a time at least, saved from its ravages.

It was in the first spread of the epidemic that the exemptions from situation were chiefly remarkable. In its subsequent visits or eruptions it rarely failed to reach the places it had left free before; and even instances are recorded of its attacking those places alone, on its second tour through a province; the others, notwithstanding their disadvantage of situation (their susceptibility being exhausted by the former visit) enjoying immunity in their turn. But in general they suffered again, and even sometimes more severely than at first. It would appear that on these subsequent occasions the disease had obtained a greater degree of virulence than at first, and choosing the most favourable time of the year for its reappearance, was thus enabled to extend over localities which were before inaccessible to it. Hence also appears to have happened the analogous fact of its reaching in those second visits the less susceptible classes of people, as well as places, as will be subsequently proved. That these places were not finally exempted, is therefore no proof that they were equally obnoxious to the disease with the others. The post-

ponement of their periods of attack, and in general their being visited to a less extent and by a milder type of the disease, sufficiently show that they were intrinsically less under its influence.

Let us now endeavour to trace the influence of localities in the epidemic in a few instances on the peninsula. Although the climate of that country greatly differs from that of Bengal, particularly in being in a great measure free from endemic fever, the disease in general seems still to have obeyed the same laws. Mr. Dean reports:—"As far as I have made any observation on the subject, a humid atmosphere is more pregnant with this pestilential disease than a dry clear one; and whenever the disorder has prevailed in the regiment, it has been more frequent and fatal under those circumstances than at other times; and from all I have heard, high situations are less exposed to the disease than others. Not one case occurred in the troops stationed on the hill forts of Trimbuck and others in Candeish, during the last season (1818), and although the disease appeared in the lower fort of Asseerghur at the commencement of the present rains, in the battalions of sepoys stationed there, yet the Europeans stationed in the upper fort did not suffer; but in a party of them invalided and marching to Jaulna, the disease appeared and several fell victims." Mr. Sutton, who gives a detailed account of the progress of the disease through the district of Nellore, states, that certain populous towns on the western frontier, and a large portion of its south-west part, entirely escaped the first year, being all somewhat elevated above the low plain which forms the rest. However, in the following year they were all visited, as well as the rest of the district, during the hottest season and commencement of the rains; and on this occasion it exhibited a more malignant form than at first. There is a table land, about fifty miles in length and half that breadth, termed the Neelgherry mountains, lying to the west of Calicut; being a part of the great range of western Ghauts, elevated from five to eight thousand feet above the sea, and consequently enjoying a temperature 25° or 30° lower than that

of the surrounding plains. From a journey made in 1821 into that interesting little plateau (which has since become an object of great attraction to the European inhabitants of the peninsula, both for health and pleasure) I ascertained that the epidemic had almost depopulated various villages situated about the highly malarious base of the plateau, but had never been able to ascend it; nor I believe has it ever since appeared there. Yet a considerable population exists on it*.

* The Neelgherry was almost unknown to the Europeans in India until a few years ago, when a pleasure party of officers accidentally ascended it, and were astonished to find on it abundance of hoar frost and ice. When I explored it in 1821 (partly in the footsteps of the distinguished naturalist, M. de Lechtenault), the thermometer stood, in the plain of Coimbatoor at its base, at 98° in the day, and sunk very little below it at night. In the course of a morning's march I easily ascended its abrupt edge, and attained the first level of about four thousand feet above the plain. There I found the thermometer rise no higher than 72°, and sink at night to 58°; which, under the circumstances, was a hyperborean cold. But to wrap ourselves at night in the new blankets provided for the occasion and keep it out, was a luxury ineffable! In other respects the change was equally great: no transportation recorded in the Arabian Nights could have been more surprising. The face of the country formed a perfect contrast with that of the plain below, which, as we looked down upon it, appeared to be covered with a burning haze. It was excessively mountainous, with patches of high forest interspersed with grassy tracts and cultivation. The trees and shrubs were in general perfectly different from those below; and among them we recognized with pleasure many of the common plants of Europe, which we never see on the common level of India; for there scarcely one of the vegetable products of England, from the forest tree to the blade of grass, exists in the state of nature. For some time it was one of our chief amusements to search out these old friends, and happy we were to shake hands even with a thistle or a nettle. Many patches of marsh are scattered over the surface, from which, as well as from the woods, malaria is to be apprehended; and from the number of attacks of intermittent which appear among the visitors of the *Hills* shortly after their arrival, I feared that that circumstance would be a great drawback to the pleasure and utility of the climate; but it appears from later observation that these attacks do not originate on the plateau. On the plain of Coimbatoor I found water boil at 210½°; at various places on the lower level of the plateau at 202°, 203°, and on the

So also, in a similar but smaller and less elevated tract of "Hills" near Salem, the disease was equally unknown; but Mr. Scot seems inclined to attribute that circumstance to non-intercourse.

Seringapatam is one of those noxious spots so devoted to fever, that they should be shunned by man as a residence if he is unable to remove the cause. It lies in a basin, formed on all sides by hills, and is surrounded to a considerable distance by rice-fields, watered from canals drawn from the Cauvery, and carried off at considerable angles from the river along the sides of the neighbouring heights. The ground between them and the parent stream is formed into a succession of terraces, and thus kept continually overflowed whilst the grain is growing, but suffered to dry up for its ripening. To the miasmata thus produced I have always attributed the fevers which prevail there*; for there is neither swamp of any other descrip-

more elevated eastern part at 197°, 198°. Calculating five hundred and fifty-five feet for every degree of the boiling point below 212°, I inferred (in a report on the medical topography of the tract made to the Medical Board of Madras), that the elevation of the first level might be about five thousand five hundred feet, of the latter eight thousand; and these rude guesses appear to have been confirmed by subsequent more scientific experiments.

* "Quos ego miserrimus vidi et pars magna fui"—for to this day I feel their effects. The 34th regiment was stationed there for one year (1814), during which time not more than twenty officers or men of the whole number escaped attacks of the fever. We buried nearly one hundred men during that time, and probably as many more after leaving the station from its effects. A company has mustered on parade only the captain and a lance-corporal! During the cold months about the beginning of the year, when the plant was growing up through the sheets of water, the disease was an intermittent; but in the hot weather, when the fields were drying or dried up, the disorder assumed the more malignant form of the bilious remittent, in its highest grade the very same with yellow fever of the West Indies; the place has since been abandoned as a station for Europeans. That rice cultivation is not always attended with the same effects, may be owing to counteracting causes. Thus, in the Carnatic the malaria may be corrected by the salubrious sea-breeze, or, as Lind supposes, by the dry and healthy though hot wind from the west.

tion nor wood for a great distance, and the natural soil is a dry reddish sandy substance, consisting almost entirely of decomposed granite. Here, as in all other similarly unhealthy places, the epidemic prevailed to an extraordinary degree. Mr. Scot states, that it appeared from the best information he possessed on the subject, that the mortality was greater there than at any other place in the peninsula. Very different was the case at Bangalore, lying on an eminence seventy-five miles to the westward, seven hundred feet higher than Seringapatam, and three thousand above the sea: it is the highest ground of the Mysore, and the coolest and healthiest station on the Establishment. It was never visited by the epidemic but in a very trifling manner. And when it reappeared there to a slight degree, during unusual heat in September, 1822, the cases were of the milder kind, characterized by increased action, as "considerable spasms, constant vomiting and purging and *bilious* discharges, bearing little resemblance to the epidemic so fatally prevalent in other parts of India." Another observer adds, that though the cases were violent, it differed steadily from the epidemic in one symptom, that of not arresting the circulation. The degree of mortality is not stated, but it is probable that it will have been very small*. It is abun-

* But then again it was observed, that when the epidemic, after being in 1818 (as already stated) arrested by the first range of the Himalaya, did in the following year penetrate into the Deyra Dhoon, situated on that range, it was found in that colder and higher tract exhibiting a rate of mortality such as was very seldom witnessed in other parts of India. Thus in one corps of nine hundred men, *though the seizures were not very numerous* (being one hundred and thirteen) the deaths were no less than seventy-four, or nearly two-thirds. This is a fact which runs directly in the face of all former experience and reasoning on the disease; but in subsequent parts of its course, a striking parallel to it occurs in the excessive mortality, though probably with fewer attacks in proportion to population, which the disease has exhibited since it entered Europe, in comparison with its general prevalence in India. — If we cannot explain a fact, let us endeavour at least to class it with other anomalous occurrences, and if they are real facts they will in time explain themselves.

dantly evident that all malaria countries have suffered in an especial degree from the epidemic. Dr. Goldie observes (in the south-eastern part of the peninsula) that it "prevailed most severely at the bottom of the mountains (eastern Ghauts), and such places where the endemic fever is known to prevail." The very same remark is made by an observer still farther south, near the extremity of the peninsula; in Dindigul too, a very feverish tract*, and in Madura and Tanjore its prevalence was long protracted. It adhered, as it were, to the malarious soil, without exhibiting that most consolatory feature, which in the healthier localities it almost always displayed, its early and rapid decline, and almost, if not quite total disappearance. This observation perfectly accords with those of Mr. Jameson with regard to Lower Bengal, and, as well as most of the others in the Madras Reports, was made prior to the appearance of the Bengal Report. In 1821, when the disease had become rare among the fixed inhabitants of the peninsula in general, Mr. Scot finds the cases most numerous in the southern division, which is the most generally feverish portion of the establishment, and particularly at Salem, Sankerrydroog, and Madura, *where fevers were also prevalent.*

Some, but very partial evidence there is, that would tend to show that this scourge has been less severe on the sea-coast than in the interior of the peninsula. Dr. Scott remarks at Madras, that this observation had been made, and offers a strong argument in support of it in the comparatively mild manner in which Madras, with its great native population, had been visited; the deaths according to the police reports amounting only to one thousand five hundred in the first prevalence of the disease. Dr. Goldie observes, that it had been comparatively mild on the coast of the southern division, and its violence increased in the ratio of the distance from the coast and approach to the Ghauts. So also at Palamcotta, farther south, Mr. Chalmers states the same fact. The very same observation is made with regard to the prevalence of the

* The endemic fever on the peninsula is termed the *Seringapatam*, the *Dindigul*, or *Jungle* fever.

epidemic fever in those districts, in the years 1809, 1810, and 1811, by the medical committee appointed to inquire into its causes*; and farther proves the identity of the great cause of fever with one of the causes of the epidemic cholera.

It is an observation as old as the first year of the epidemic, that it has shown a marked disposition to spread along the banks of rivers; nay, the very first notice of it in the epidemic form is its thus extending along the Megna in May 1817. It has been chiefly remarked on the great rivers of Bengal. Mr. Jameson says, "from the rise of the disorder on the banks of the Ganges and Burrampooter, to its arrival at the months of the Nerbudda and Taptee, this has excited the surprise of the medical observer. Thus from Sunergong in the Dacca district, where the epidemic broke out in July 1817, it crept along the banks of the Megna to Narriangunge and Dacca, attaching itself chiefly to the ferries and market-places in its vicinity. In like manner it afterwards advanced step by step up the Burrampooter, affecting during its transit the villages situated on both its margins. From the mouth of the Hoogly to its termination in the Ganges near Moorshedabad, the same peculiarity was observable. The shipping at the new anchorage at Diamond Harbour, and along the whole channel as high as the Hoogly, was particularly affected, and almost every village adjacent to its banks buried many of its inhabitants. In the Bhaugulpore district the propensity was so strong, that the virus scarcely ever spread into the interior, whilst it almost depopulated the low lands near the Ganges. Again, in the autumn of 1817, Moozufferpore, and the villages along the Gunduk river in Tirhoot, and the station of Chupra on a branch of the Ganges in Sarun, were alone visited, while at a subsequent period the disease was thence communicated along the Gogra to numerous cities in the north-east quarter of our territories. From Allahabad upwards, along the channel of the twin branches there forming a junction, until the river was lost under the hills, it wavered so little from the line of those rivers, that hardly a town or village lying remote

* See p. 195 of this work.

from their course was brought within its influence. Without going further over our old ground, let us briefly state, that the same rule held yet more unexceptionably in Rajpootana, through the province of Bundlecund, and all along the Nerbudda to the numerous branches of the Chumbul."

Dr. Goldie observes the epidemic appearing early on the Cauvery, and being more severe in general on the banks of rivers than other places; and Mr. Neilson reports from Ramnad: "The cholera has been observed to take the course of rivers more or less, and has always been more destructive in villages whose situations are low, and contiguous to wet paddy (rice) fields. In some of the largest and most populous places whose sites are elevated, it has not as yet appeared at all, though at the distance of only ten or twelve miles; in places otherwise situated it has been very prevalent*." These countries are partially, and at times, subject to fevers; but I have seen and heard of so many instances of parties of troops being attacked with the disease on the banks of rivers, in tracts of country where malaria does not exist so as to produce fever, as in the Ceded Districts, the Nizam's territory, parts of Mysore, &c., that it seems to be quite evident that there is something about the banks of all the rivers in India tending to produce the disease.

To what are we to attribute this characteristic of the epidemic? Its explanation, though not single, is very obvious—human intercourse and malaria. The great rivers of Bengal are also the great channels of internal communication, which is carried on either on their surfaces, or on the roads along their banks. The most populous places all lie on the rivers, and the intercourse between them must be very great.—No wonder that this especial visitant of man is found accompanying him on his journeys: such has also been the case on the great rivers of Russia, and the fact has been traced to the same cause. But on the peninsula of India the case is very different, for there navigation is scarcely carried on even to the most trifling extent on any

* P. 136, 140.

one of the rivers, and scarcely an instance can be mentioned of a great road running on the bank of a river, for they almost all cross them; but the existence of the other cause, malaria, in these situations has already been made evident. In the southern division, where chiefly the observations of the disease attending the peninsular rivers have been made, the streams which cross that wide plain are continually diverted from their course on each side into canals and tanks, and thus spread out over the broad margins and expanses of rice-ground which attend them, and leave the sea, except in the rains, but a small tribute of their waters*. This is particularly the case with the Cauvery, in this lower part of its course, as I have already described it at Seringapatam. It appears also, from Mr. Jameson's observations, that malaria has had an immense influence in producing the great prevalence of the disease on the rivers in Bengal. It may be further remarked, that if there is any thing in low situations, independent of malaria, favourable to its existence, the disease must find it in the course of the rivers; for they necessarily run in the lowest parts of the countries which they traverse.

We have seen how strongly the epidemic has been influenced by situation, in the great features of its extension over the various countries of India: the same facts are equally evident on the smaller scale of its progress through the particular cities and camps. It is constantly

* One of these rivers ends in a tank at Ramnad; and it is stated in the report of the medical committee on the epidemic fever in those districts, that in the heavy rains of 1810 attending that fever, the tank, which is usually not full for seven years together, broke its banks and ran into the sea. The influence of this local cause on the disease has not escaped Mr. Scot. He observes, "In a considerable portion of the southern territories, rice culture takes place from the inundation of the Cauvery, which is swollen by the western rains, thus placing the surface of the soil under water, while perhaps the appearances of the atmosphere are such as belong exclusively to the dry season. Accordingly these countries are frequently the seat of epidemic sickness, and they have suffered considerably, and with less interruption from attacks of cholera." — *Appendix*, p. 6.

found to select the low, damp, confined, and filthy parts of a city or its suburbs. Some of the facts from which this inference is formed have already been brought forward. I will not trespass on the reader's patience with the numerous others on record to the same effect, but merely refer to the experience of Mr. Jameson at Calcutta, Benares, &c.; Dr. Scott at Madras; and different observers at the other cities of the Peninsula, Trichinopoly, Palamcotta, &c. A few particular occurrences there are, however, too remarkable to be passed over without notice. In a large camp in Candeish, one corps at the left of the line was found to suffer extremely from the disease, whilst that which was at the opposite extremity entirely escaped. The former was in a lower and more confined situation than the other, the latter being situated between two hills, where there was a strong current of air. On the corps which escaped marching, another corps arrived and took its place, and enjoyed the same immunity, the epidemic still existing in other parts of the camp*. And that the exemption was not owing to want of susceptibility was proved, at least in one instance; for the first of these corps suffered very severely on its march after leaving the station†. The 53d regiment were situated in an airy and rather high situation at Trichinopoly, when the disease appeared: they did not escape, but they were attacked the last. It first appeared at Masulipatam among convicts in a *bomb-proof* (a chamber like a cave in the ramparts), and was for some time confined to that chamber, before it appeared in the rest. It was different from the other bomb-proofs, in being ill-ventilated, crowded, and extremely damp. Throughout it furnished more cases than the others. Some further time elapsed before the disease spread to the free population. Other prisoners in a dry and commodious jail, at the same time, suffered much less‡. Two parties of European recruits arriving at Madras, one is sent into bomb-proofs

* Report, p. 89.

† Annesley on Cholera, p. 215.

‡ P. 89.

in the fort, and the other into barracks at the Mount, eight miles off. The former is attacked whilst the latter remains free, and on being also sent to the Mount has no more cases*. A corps encamped on low ground in very rainy weather was severely visited: of thirteen sepoys taken ill, six died. After a few days they moved to a higher spot, and only one more case occurs, which appears on the march to the new ground. During an attack of the epidemic experienced in April, 1823, by the 69th regiment in quarters, at the suggestion of the surgeon, the wing of the corps in which the disease prevailed the most was encamped on a piece of high ground in the neighbourhood, and he reports that not a case occurred in that camp†. Mr. Mitchell reports, on a reappearance of the disease at Palamcotta, "It commenced its ravages to the north-east of the fort, and spread pretty generally through the small, low, dirty, and close houses in every direction. The hospital escaped its influence, probably because it stood on high ground and was very open all round, for certainly none of the sick, though upwards of ninety, were attacked. Only one person about the hospital was attacked, and he was in the habit of absenting himself from it at night."

Dr. Henderson relates, that he was encamped with a division of the army in Burmah, in 1825, on jungly ground, when the disease suddenly broke out in the camp, fifteen or twenty persons dying of it in one day. On the following day the camp was moved to a higher ground a mile and a half distant, after which not a single case occurred. The same officer observes a particular barrack room in Fort St. George being exceedingly obnoxious to cholera (on one occasion many cases appearing in it and none in the rest), which was attributed to its contiguity to the ditch of the fort, the men's privies, and an offensive drain‡. Mr. Jameson gives various instances of high and dry cantonments and other spots suffer-

* P. 89, 37, 38. † P. 1.

‡ Searle on Cholera, p. 60.

ing little or not at all, whilst the neighbouring cities were severely scourged; and many more of close, filthy, and crowded cities suffering severely, whilst others of the opposite description almost escaped. Thus it was with Agra and Muttra, two cities on the Jumna, only forty miles asunder. At the latter place, which was severely visited, the extensive cantonments in its neighbourhood remained unaffected upwards of three weeks, whilst the disease was prevailing in the city, and then it began in their most distant part, nearly two miles from the city, which was on low ground near the river, and progressively extended to the other end of the line, which gradually ascended from the river. "The Rajapootana force previously to the appearance of the disease was encamped on a ridge of sandy soil, sloping for a mile or two to a much lower tract. The grass was thicker to the left of the camp, where the declivity was too gentle to allow the water to flow off speedily. On this side of the line the disease broke out earlier, and was throughout more violent than in its right division. No cause could be assigned for this irregularity of action, except that in one part the tents were pitched higher, and were consequently drier than the other*.

It is sufficiently remarkable (as appears in so many of the above instances), that the disease not only prevails most, but appears first in these obnoxious parts of a city or neighbourhood; and that fact, as well as some others just stated, which would appear to give almost a paramount importance to locality, are somewhat adverse to the doctrine of contagion. But it is at least as likely to be imported into such places as others; and be it always remembered, that it is not contagion alone that we are to look to for the origin of the epidemic, for without contingent favourable circumstances it is harmless; and in particular the faint spark of *imported* contagion must probably in general require such aids to fan it into a flame.

In the Calcutta Journal (September, 1820) it is stated,

* P. 116.

that "the station at Light-house Point is so unhealthy, that hitherto only one European (a French carpenter) has been found capable of enduring the climate. This station, independent of the fevers which prevail there, was twice during the last season visited by the cholera, though it did not make its appearance at any other station on the island."

Mr. Chapman relates his having encamped with a party on the banks of a nullah containing much stagnant water, and that the cholera broke out in them with great violence a few hours after. On another occasion he states, that the grass-cutters of his party were found to suffer severely from cholera, whilst the rest of the party suffered little. Out of eighteen of these people, five died in three weeks, and as many more were attacked. They were resorting daily to a putrid standing pool for the purpose of washing their grass*. They had themselves connected the attacks with this pool, and of their own accord deserted it, after which no further cases occurred, during a stay of nine weeks at the place. He also describes the situation of Nagracoil, a town on the boundary of Travancore, which was notorious for cholera (the disease being, as already stated, endemic in that district), for it continually existed among the inhabitants, and troops were often attacked on halting there. "The immediate neighbourhood is flat, and it accordingly happens that much water is collected in the low situations during the rains, which in Travancore are exceedingly irregular†."

Mr. Searle maintains that malaria is the primary cause of the epidemic, and in addition to many facts and arguments in support of that opinion, adduces a very striking instance,

* The mode of collecting grass for horses in India is somewhat curious. The grass is the *doob*, or *fiorin*, which spreads its roots far along the ground, and they are at least as nutritious as the herb itself. They dig up these roots with what the sun has left of the grass, and wash them in the nearest water. On the return of the rains, the grass instantly shoots up again from the remainder of the roots.

† P. 182, 197.

where that cause appears to have alone produced a general attack of cholera, in a school at Clapham, in August, 1829. A very foul drain or cess-pool was opened, and its contents thrown out in a garden adjoining the school. A day or two afterwards one of the boys was attacked, and in two days more twenty others, out of the total thirty. The disease appears to have considerably resembled the Indian epidemic, the evacuations being usually untinged with bile. Two cases terminated fatally. It was held by the highly respectable medical authorities assembled on the occasion, that the effluvia from the putrid matter had produced the disease.

We have seen that the endemic cholera is found in India extensively prevailing only in localities where the existence of malaria is evident, from their nature and from the prevalence of intermittent and remittent fevers; a fact which strongly coincides with the observations of Dr. Macculloch. He concludes that the common cholera of England arises, not immediately from the heats of autumn, but from malaria. "Cholera belongs predominantly, if not exclusively, to the same climates, the same soils, or generally to all those countries and places in which the diseases of malaria abound; and if as numerous in respect to cases as these are in such places, resembling them also in severity. Reversely, it is rare in the reverse climates and countries or places. Of this we shall easily be convinced even in our own; as the most superficial examination will show that this disorder is common when fevers are common, and rare when they are rare; that the places where both appear, are precisely those which indicate the existence or probability of malaria, and that autumn is equally the period of all. What may also serve to confirm this is, that where the present autumn, 1826, like some of the preceding, has been remarkable for the number of fevers, these having been also conspicuous for heat, and for the prevalence of east winds, cholera has been far more frequent than in former and distant years; and that it has thus appeared even

in Scotland, and always most remarkably in low and wet situations, where its existence had formerly been unknown*."

Dr. Macculloch also conceives, that the same or a similar cause is the primary agent in the production of the Indian epidemic, but admits that his views regarding that disease must be considered rather in the light of queries than inferences. The principal circumstance from which he forms them is the single fact of the crew of a vessel, lying three miles off one of the coasts of India, where the epidemic was prevailing, being suddenly attacked with it during the blowing of a wind from the land, which had a smell, said to be that of malaria, and after having had no communication with the shore for many weeks. This would appear to be a case of an epidemical attack of the disease arising without contagion, but it is evidence very inadequate to the establishment of so important a fact, in the face of so much of an opposite nature. It is highly improbable that a vessel should lie or cruise off a friendly shore for any length of time, without at least getting supplies of provisions from it. The period of non-intercourse ("many weeks") is too indefinite; it may not have been greater than the latent period of the disease might extend to, and certainly was not longer than the contagion might exist in fomites—to say nothing of the possibility of its being conveyed three miles by the wind. It has been shown that the disease actually is propagated by contagion; and that the supposition of malaria as its primary and essential cause is not only gratuitous, but utterly at variance with the phenomena.

It is however perfectly evident that malaria, where it

* Essay on Marsh Fever, &c., vol. i, p. 228. It was observed at Riga, that the carriers of hemp suffered from the epidemic cholera in a much greater proportion than the rest of the population. Is not that to be attributed to malaria? The putrefactive process by which the fibres are separated from the rest of the plant must be highly productive of that principle, and in fact is proved by experience to be a source of fever.

existed, has proved one of the principal causes of the epidemic, and if we had a knowledge of the nature of that agent, it might throw light on that of the disease; but this is one of the many arcana of physic. It has long been known that a noxious principle existed in the air of marshes; and since the discovery of the different gases, and the acquisition of the great powers of analysis which chemistry has made of later years, specious hopes were entertained of discovering by that means the nature of that deleterious property. These experiments have often been made, and have resulted in proving that the composition of the air over marshes differs not from that of healthy air, in any appreciable quantity of any *ponderable* substance;—yet chemical analysis is capable of detecting and ascertaining the nature of most minute portions of matters subjected to it, whether in the solid, liquid, or æriform state *. It is therefore an agent of a different nature which we must look for in malaria, and Read seems to have informed us what that agent is, by the discovery he has made of negative electricity being produced in the air by vegetable putrefaction. He found electricity in the minus state in the air over a dunghill—in a privy—at one end of a school-room which was situated over a sewer and had a bad smell, whilst at the other end it was plus;—doubtless he would have found the former condition still more strongly over the opened cesspool of the Clapham school—in the Fleet Ditch, or the sewers of the Salpetrière—and, in all probability, at that end of the barracks at Madras, which was next to an offensive drain and the common privies, and which was so particularly obnoxious to cholera, and a different state at its oppo-

* Dr. Macculloch states: "Experiments carefully conducted (as ought not to be doubted when Vauquelin has been engaged in them) have not detected even the presence of any new substance in the atmosphere of marshes, far less its nature. It is, however, evident that it cannot be any of the hydrocarburetted or other chemical gases, which it has at different times been supposed; while remaining thus in darkness, the only test of its presence continues to be its effects as to disease which it produces on the human body."—Quarterly Journal, 1827.

site end. It is equally probable that the same difference will be found between the air situated over the damp ground-floor, with its *earthy* smell, of a building in a malarious situation, and that of its upper stories, whose inhabitants are comparatively free from fever. In fact, the observations that have been made regarding the habitudes of malaria — its varying force at various hours — its partiality — its affinity for the surface of the earth, for close situations, and for atmospheric moisture — so closely correspond to the circumstances in which the negative state of electricity of the air has been found to prevail, as to complete the conviction in my mind of their identity.

Moreover, there is reason to believe that the same morbific condition of the air is produced by the process of vegetation. M. Pouillet states, that "the carbonic acid emitted by vegetables is charged with resinous electricity*." Woods, thickets, and even meadows are found to be productive of malaria in the summers of temperate countries; but it is amidst the exuberant vegetation of the tropical forest, and apparently at the times of the year when that process is carried on with the greatest intensity, that the effects of that arch-enemy of human life and health are most apparent. I have often been perplexed to find a sufficient quantity of decaying leaves in the jungles of India to countenance the belief that vegetable putrefaction was in that case the primary cause.

But it may be asked, why then does not a thunder-storm produce intermittents as well as the Pontine marshes, the rice fields of Seringapatam, or the jungles of Dindigul? The answer is not far to seek: electricity exists under various modifications. The electricity of the machine is one thing, and that of the galvanic battery another; and again, in the latter process, the greatest differences, not only in the degree but the kind of effects, are found to arise according to the *different modes* in which the agent is produced. Thus a single pair of plates of great size produces an electricity which exhibits the phenomena of combustion in the highest degree, but is *incapable of*

* Thomson on Heat and Electricity, p. 440.

passing through imperfect conductors, has little effect on the electrometer, in giving shocks to the animal frame, or disturbing the chemical affinities of bodies exposed to it; whilst a battery of many small pairs, forming together the same extent of surface as the single large one, produces apparently another electricity, which passes readily through imperfect conductors, strongly affects the electrometer, gives acute shocks, and has great chemical powers, but no remarkable capacity of melting pieces of wire interposed between its poles. And the effects are further varied by varying the nature of the fluid used in the process. The substitution of pure water for the acid liquor, abstracts the chemical energies of the apparatus without destroying its powers of giving shocks or its influence on the electrometer *. We are not therefore constrained to admit that the electricity of malaria is the very same with that of the thunder-cloud; as in the first of these situations it may exist under one of those modifications, and the second under another, or some other still undiscovered. Does the electricity of the thunder-cloud and of the atmosphere in general consist of that form which is termed "intensity," and that of malaria of that which is termed "quantity?" In malaria it appears to arise from chemical sources, vegetable putrefaction, and probably from that process of plants which is analogous to respiration; in the other case, perhaps from very different sources, for the electricity of the atmosphere has been commonly attributed to the friction of its masses on each other or on other bodies, to induction, and to rarefaction and condensation. From the very imperfect knowledge which I possess of these subjects, it is with unfeigned diffidence that I offer these suggestions; but the common mariner may be thrown, without compass or rudder, on an unknown shore which a Columbus was unable to discover; and if the obscurer regions of science were only to be explored by means of the regular approaches and the rare sagacity of a Newton or a Davy, its *terræ incognitæ,* wide as they are, would be infinitely wider.

* Brande's Chemistry, third edition, vol. i, p. 90.

SECTION V.

OF THE PREVALENCE OF OTHER DISEASES IN CONNECTION WITH THAT OF CHOLERA.

PROPOSITION XIII. The extensive prevalence of various other endemic or epidemic diseases, particularly the malaria fevers, has often accompanied or immediately preceded or followed that of the epidemic cholera.

IT has already been stated in the original part of the work, that the great atmospheric cause of this epidemic has appeared simultaneously to produce the extraordinary frequency of other disorders; and so numerous are the proofs of this fact, that it appears to me that it may be considered one of the laws of the disease.

It has been shown that the year 1816 was equally remarkable in Bengal for the intemperature and irregularity of its seasons, and an extraordinary visitation of remittent fever over almost all that immense country *. This, then, was the forerunner of the graver type of disease which a similar but greater aberration of nature developed in

* It is evident that this disease prevailed to a very violent degree and great extent. At Cawnpoor, where its ravages were greatest, it began in August (the middle of the monsoon), and withdrew on the setting in of the cold weather in December. One European corps there alone, had five hundred and nineteen men in hospital at once, and buried ninety men in one month, which, Mr. Jameson adds, is a degree of mortality far exceeding any thing then on record in the medical annals of Bengal.

the same country in the following year. Mr. Jameson states, that in the year 1816 there also prevailed in Bengal "an infectious malignant cynanche, a disease previously known only by name in this quarter of the globe." And a similar and equally extraordinary occurrence took place that year on the other side of the peninsula; for a disease which appears from the particular accounts I have received from Mr. J. Orton (who was in the neighbourhood at the time) to have been the true, inguinal plague, appeared at Mundavie on the coast of Kutch, and spread with great fatality to a considerable extent in that neighbourhood. It was believed to have been imported by Arabs from the Red Sea. These circumstances strongly indicate an uncommon "epidemical constitution" of the atmosphere.

Mr. Jameson, in the course of an inquiry into the question whether this epidemic, like others, has a tendency to absorb or convert into itself other usual diseases, shows, it is true, that great variety has existed in the extent of prevalence of other diseases at the same time with cholera. He finds, however, scarcely any instance in which the other endemics were less prevalent, but mentions several where they were as usual; from whence he infers, that the cholera had no influence in transmuting into its own specific mode of action other forms of disease. But by far the most prominent part of this evidence is the increased prevalence of the common endemics at the same times and places with the visitations of cholera. "In the Nagpore force, bilious remittents were more than commonly prevalent during the existence of the epidemic, and the season was particularly sickly all over the province of Berar. Throughout the Saugor province, the small-pox raged at the same time with cholera. A like circumstance occurred at Cawnpore, in which the small-pox was extremely fatal in April and May 1818, when the city was visited by the epidemic, and in Calcutta in the spring of 1819, at the very time in which cholera was in one of its periods of greatest aggravation. In like manner, autumnal

intermittents were common in the Rajapootana force during August and September, and in the cities of Jeypore and Delhi, fevers of the remittent and intermittent type, diarrhœas and dysenteries, continued very prevalent until the end of the cold weather. In Nuddea, remittent fevers, liver and bowel complaints, were more than usually frequent among Europeans. In Dacca fevers were, during the first year, less frequent, in the second more general and obstinate. In Sylhet, intermittent and remittent fevers, running into and alternating with dysentery, were more than usually common; and it was remarked, that so far from showing any disposition to coalesce with cholera, an attack of the one disease generally protected the person attacked from the influence of the other. In Tipperah intermittents, and in Backergunge bowel complaints were more general than in former years*." And in the left division of the army in Bundlecund, in May 1818, on the abatement of the cholera, during a continuance of sultry disturbed states of the atmosphere, remittent fevers and diarrhœa were very prevalent.

Again in 1819, Mr. Jameson observes, at Cawnpore "the epidemic soon gave way to violent remittent fever, which proved exceedingly severe and fatal, especially among the European troops, sometimes cutting off the patient almost instantaneously, with every symptom of apoplexy†;" and at Meerut about the same time, the "hidden epidemical constitution of the air," as Sydenham would have termed it, is found to pass immediately from the production of cholera to that of a malignant type of dysentery‡. In May 1820 (a time when numerous revivals of the epidemic took place, for

* P. 187.

† Dr. Tytler states the same fact, adding, that the disease perfectly resembled the yellow fever of the West Indies, and that he considered it "the second stage of the morbus oryzeus, or degree of intensity in which the fatal disorder occasioned by noxious rice occurs."—*Asiatic Mirror.*

‡ P. 120, 305, 311.

that month is of all others the most obnoxious to them) it is again stated, that Cawnpore is suffering severely from fever, the 11th dragoons burying eight men a day for several days. And in the same autumn, Moorshedabad is stated to have been very unhealthy from cholera, succeeded by fevers *.

On the peninsula too, we were not slow in observing similar coincidences. In the remarkable instance already mentioned, of a corps having suffered severely from this disease in 1814, it is recorded that when the cholera ceased, during the continuance of excessive rains, it was immediately followed by diarrhœa, which gradually verged into an epidemic dysentery. In the very first report of the appearance of the epidemic on the Madras establishment, it is stated that the inhabitants of Ganjam (a feverish place) were "suffering from fever and cholera." Mr. Scot adds, that the former continued to prevail in many parts of the district for a whole year after. He further states, that in an European corps at Mulligaum, when the cholera declined, a bilious remittent became very prevalent. In September following, the surgeon of the corps reports its continuance and extraordinary malignancy, together with a few cases of cholera, and adds, "the air of Candeish is so bad that the blisters ulcerate and slough, in some instances to a great extent. In one case a large portion of the cranium was denuded." So also in the feverish districts of Madura and Dindigul, Mr. Scot states the endemic fever to have prevailed to a great extent at the same time with the cholera. At Seringapatam this was eminently to have been expected, but no reports appear to have been received from that station. In Coimbatoor, another feverish tract, the endemic fever prevailed along with the cholera, and increased as the latter disappeared. In a severe attack of the epidemic experienced in the 16th N. I., fever was very prevalent shortly before the cholera, and during and after it both fever and diarrhœa. And in the

* Calcutta Journal.

15th regiment, the cholera was preceded by diarrhœa and intermittents, and followed by a very prevalent dysentery. At Samulcotta it was observed that two-thirds of the convalescents from cholera were attacked with dysentery. At Calicut the prevalence of chicken-pox along with cholera is reported. The Madras Gazette (edited by Mr. M'Leod, a most intelligent medical officer) states, in July 1819: "During the last week our correspondent's letters are filled with alarms excited by the second approach of this dreadful scourge (the cholera). The alarm occasioned by its peculiar malignancy in Travancore is very great. The mortality among the natives is said to be dreadful; and, as if it was not misery sufficient to be troubled with one plague, a malignant fever had broken out, and was attacking such as the cholera passed by." And in September 1824, the following paragraph appears in the same journal. "The fever with which Madras has been so long visited, still continues. * * * It is with extreme regret we find the cholera has again appeared among us. The many deaths which have occurred during the present season are truly awful. Until a considerable quantity of rain has fallen, we fear Madras will continue unhealthy: we hope therefore the few showers we have received will be in part of a plentiful supply." In ordinary times fever is rare at Madras.

On the Bombay establishment, similar facts have excited the most marked observation. Dr. Kennedy states, that the attack of cholera at Surat in 1818 had been less severe than was expected: "But although the cholera was not carrying off its thousands, still the epidemic fever, which always prevails towards the termination of the rains in Guzuratte, was singularly destructive. The pestilence had not spread, nor did the general average of the sick appear much to exceed the customary numbers for the period of the year; yet the mortality was unprecedented, every disorder seeming to assume from the first a tendency to a fatal termination."

"This was my first opportunity of witnessing the disease.

During the cold months from October to February we had no alarm; but in the heats of March and April 1819, the cholera was again to be noticed in every hospital report, but happily without any wide-spreading destruction. The cases were not exceedingly numerous, nor did their occurrence continue after the first fall of rain in June; but it was again remarked, that the mortality from other causes appeared unprecedented. Two kinds of fevers are endemical in Guzuratte. From September to December intermittents prevail, and in October we have nearly every fourth person disabled; but in the heat of April and May, when the thermometer in the open air is from 80° to 90° at midnight! bilious fevers are frequent, and though not so generally prevalent, yet, from their more virulent character, they occasion, at least, an equal number of casualties. But the usual average of deaths, always greatest at these periods, was increased in a prodigious proportion during intervals when cases of cholera were of occasional occurrence." These observations of the change of type of the fever perfectly agree with my own, already stated, at Seringapatam. Dr. Kennedy repeatedly finds the cholera reappearing at the very same time when this malignant transformation of the common endemic takes place; it is therefore fairly to be inferred that these occurrences are owing to a common cause. In like manner we find malaria in England producing in the spring only intermittents, but in autumn remittents, accompanied with cholera.

It appears also from statements in Mr. Marshall's Medical Topography, that a severe fever had prevailed very generally over the malarious parts of that island in 1818, when the cholera was ravaging the peninsula, but before it had reached the island, and that sloughing ulcers had also been exceedingly prevalent. And in the spring of 1819, when the cholera overran the island, he mentions various stations having suffered very severely also from fever, particularly Fort King, a considerable post, where not a single European entirely escaped the disease, although until then it had been

healthy *. This station was attacked with fever in March. The cholera overspread the interior of the island in that and the following month †.

In perfect accordance with the foregoing observations, the medical returns of the Madras army show a very marked increase of disease *independent of cholera*, whilst the epidemic was prevailing in India, as will appear from the following table extracted from Mr. Scot's work.

PROPORTION OF CASES OF DISEASE IN ONE YEAR TO THE TOTAL NUMBER OF THE MADRAS ARMY.

Years.	Including Cholera.		Excluding Cholera.	
	Europeans.	Natives.	Europeans.	Natives.
1815	158 pr. cent.	60 pr. cent.	158 pr. cent.	60 pr. cent.
1816	142 —	60 —	141 —	60 —
1817	166 —	70 —	165 —	69 —
1818	204 —	84 —	189 —	78 —
1819	199 —	94 —	190 —	88 —
1820	184 —	81 —	180 —	77 —
1821	182 —	60 —	178 —	57 —
1822	164 —	48 —	157 —	47 —
1823	163 —	48 —	160 —	47 —

Connected with this part of the subject I find another

* One of these epidemical attacks was as sudden as any of those of the cholera. "The troops in the post of Nalandy became suddenly very unhealthy about the 10th or 11th of January. There were thirty-four Europeans on duty at this post, twenty-one of whom were attacked with fever in the course of twenty-four hours; fourteen of the whole number died." These circumstances indicate general atmospheric influence. It is not to be supposed that any change so sudden took place in the formation of malaria, at least without evident causes. The Ceylon Government Gazette of the 7th of August, 1819, also states: "The small-pox, we are sorry to state, has appeared in Columbo and the neighbourhood. * * * The epidemic cholera has again broken out at Trincomallee and Galle."

† P. 99.

remarkable fact, that a particular prevalence of the endemic or sporadic cholera has preceded the great stream of the epidemic. In Bengal the first circumstance which excited attention to the disease, was the greater frequency than usual of the straggling, sporadic form of the disorder in those tracts where it always prevailed at the time of the year; and this has apparently gone on increasing until it became contagious, and then rapidly assumed the epidemic form. In this shape it did not reach Calcutta until August 1817; but Mr. Jameson states, that in the first half of the year the sporadic cholera had appeared earlier, and was rather more frequent than in ordinary years. On the peninsula, except in one small district, endemic cholera has been usually unfrequent. It appears from a table in the Madras Report, that the number of cases of it occurring in the Madras army were, in 1815, one hundred and fifty-two; in 1816, one hundred and eighty-nine; and in 1817, two hundred and eighty-two: but it was not until the spring of next year that the epidemic reached any part of that force. So also the staff-surgeon of Travancore (the district above excepted) reports, that it had been unusually frequent in the natives in 1817, one hundred persons having died of it at the capital; and when the epidemic actually reached the district, in its due course, he was unable to fix the period of its arrival, from its mixing with the endemic form. In like manner also Mr. Craw finds (as already stated) numerous cases occurring in the rains of 1817 at a station near Bombay, where the epidemic did not arrive till the autumn of 1818. These facts are too numerous and consistent to be accidental. They seem to show that the atmospheric cause was capable of producing the disease in its ordinary non-contagious form, to some, but a trifling extent, in countries distant from that in which the epidemic originated, independent of imported contagion. The insufficiency of the former alone (as well as all its common exciting causes) to produce the epidemic, is strongly set forth by Mr. Jameson: "During the numerous campaigns which have been under-

taken since the first establishment of the British empire in India, our soldiers, both European and native, have been exposed times without number to every possible variety of weather, during all the seasons of the year, without being subjected to the pestilence which nearly depopulated the camp of the Marquis of Hastings. * * * This was strongly exemplified in the case of the Nagpore force, which had not a case of the disease whilst conducting the siege of Chanda, during which the troops were exposed to the great heats of day, under a range of stony hills, and often without shelter from the dews of night; and yet no sooner did they reach Nagpour, than it assailed them with violence. * * * So, also, the left division had undergone great fatigue and privations, with great heat during the day and cold at night, for above a month; yet they felt nothing of the epidemic until, on the 9th or 10th of April, they reached Jubulpore, in which town it had been raging several weeks. * * * Nearly all the corps moving on Hansi and Hissar must have met with rain during the advance from various points in the Dooab. The 29th regiment N. I. was, we know, exposed to excessively wet weather during the whole of its march from Aligur, still it continued entirely exempt till at Hansi it joined these corps, which had got the epidemic in passing through Delhi."

But, on the other hand, we have seen that the contagion appears to have required, and to have been eminently assisted in its operation by contingent causes; and the existence of a general morbific influence throughout India, to which its diffusion is to be attributed, is further manifest from the extraordinary prevalence of so many other diseases in evident connection with the cholera. How far the epidemic in its spread through the eastern parts of Europe has been attended by similar indications of a general disordered state of the atmosphere, from unusual meteorological phenomena and the prevalence of other epidemics, or whether it has there been able to dispense with such assistance, for want

of sufficient evidence on either side of the question I am unable to decide. But until the latter is proved to have been the case, the former is most probable, from experience in India and from all analogy.

Another circumstance in proof of a general morbific influence is the fact, that the inferior animals have often suffered extensively from disease during the prevalence of cholera. Mr. Jameson says: "It was observed in many places, that an unusual mortality occurred amongst black cattle, sheep, dogs, and other domestic animals. Thus in the Backergunge district, cattle had the disorder, and were cured by opium and other remedies found most serviceable in the human species. Cows when seized shed their young. So in Tipperah, great numbers of horned cattle and sheep were seized with vomiting and convulsions, and suddenly expired. In 1815 again, half the cattle of the lower part of Tipperah were carred off by a disease similar to cholera. In Delhi dogs died rapidly, and more horses than usual were carried off by the dry gripes*.

"In the Rajpootana force, and throughout the whole of the Jeypore and Nagpore territories, the season was remarkably fatal to camels; and in the Centre division domestic animals of all descriptions died in great numbers; bnt in the latter instance the mortality might be ascribed to want of proper care and food. At Sumbhulpore an elephant had every symptom of cholera; and was cured by brandy and laudanum. But the affection of brutes was by no means general. In many districts, the lower order of animals are

* "In this city, a curious thing was, that large swarms of flies, which had infested the place before the breaking out of the epidemic, wholly disappeared during its prevalence; and returned as it withdrew. This might be owing to the cold, sharp, westerly wind then blowing."

I believe I have also noticed the disappearance of the swarms of flies with which India is infested in hot weather, on the appearance of the cholera. But with regard to the *vomiting* of the cows and sheep, we must suppose that it was a native exaggeration.

expressly stated to have enjoyed their usual health: so that the circumstance of their sickness in other quarters, during the prevalence of the epidemic, may have been perfectly fortuitous."

Mr. Chalmers reports, from near the southern extremity of the peninsula: "It is a curious fact, that in the towns near the hills, where the epidemic was so fatal, a disease occurred among the cattle, which kept pace with, and often exceeded in mortality that of the human species." During the epidemic fever of 1810, the same circumstance occurred in these districts, and in the same particular localities. Mr. Searle also states, that during the prevalence of the cholera at Manantoddy he had observed an extraordinary mortality among poultry; and he quotes Dr. Ranken's statement of many camels, goats, and other animals having died of violent diarrhœas and other ailments in Rajapootana. He further states, that the collector of the Madura district had informed him that similar mortality had not only been reported to him from various parts of his district, but urged in excuse of non-payment of the revenue. And he had heard that the same was the case in Coimbatoor. It appears the same facts have been observed in Europe. Dr. Joenichen asserts, that both at Taganrog and Moscow it is universally admitted that several species of animals have died with symptoms characteristic of cholera, as geese, turkeys, fowls, and crows. At Berlin the domestic animals and even the fish are stated to have suffered simultaneously. It could scarcely be expected that such occurrences would be general, for we know that the lower animals are insusceptible of most of our diseases; and we have seen apparently slight shades of difference of susceptibility in different classes of people have great influence in inviting or warding off the attacks of cholera.

SECTION VI.

OF THE SUSCEPTIBILITY OR PREDISPOSITION OF THE SUBJECT TO THE DISEASE, AND OF ITS EXCITING CAUSES.

PROPOSITION XIV. In every body of people there is a large proportion incapable of receiving the disease, though exposed to all its usual causes.

XV. Having undergone an attack of the disease confers a great degree of immunity, at least for a time, from its future attacks.

XVI. The indigent part of society, the old, the weakly or unhealthy, and the intemperate, are particularly liable to the disease.

XVII. The usual exciting causes of the disease are exposure to great heat, cold, or moisture, errors of diet, over-exertion, the depressing passions, and in general whatever tends to debilitate or disorder the frame.

THE facts and observations that may be collected regarding the susceptibility or predisposition of the subject to the disorder, appear to be highly interesting and valuable; for we constantly find this great immediate cause of disease exerting immense influence in inducing the attacks of this epidemic, and often the circumstances out of which it arises are very clearly marked. It is evidently to the greater or less degree, or presence or absence of this condition, that we are to attribute those most surprising, and at first sight apparently

fortuitous facts, which so often occur in the history of the epidemic, of one body of people suffering severely whilst another suffers slightly or not at all, all external circumstances being alike in both, and free intercourse existing between them — of one corps in the midst of a large community being singled out, and alone suffering in a high degree, or alone escaping whilst the hand of pestilence is striking down its numerous victims all around them. To this too, are to be chiefly attributed the great suffering of some classes, whilst other classes of the same community mixed up with them almost or entirely escape, and the constant immunity which the great mass of all classes or bodies of people enjoy; for this disease has probably never been found to attack so many as one-half of any body of people, large or small. The remote causes of these exemptions are highly worthy of our investigation, for it is evident that if we were fully acquainted with them, they must indicate efficient means of preventing in many instances a disease which we too often find it impossible to cure.

The clearest and most striking general observation which occurs regarding the prevalence of the disease in different classes of people, is, that the higher ranks of society have been found in India to suffer less than the lower; and this seems to hold good through all its branches, military as well as civil, Native and European. If we could divide the population of India on this principle into two classes, in the same manner as we have bisected the year, it is probable that we should find the less fortunate half affected in the same proportion to the rest, as are the six summer months compared with those in which the sun is on the other side of the line. Thus we constantly find that the officer suffers less than the soldier or the sepoy; that the superior description of troops, as the cavalry, &c. (who form the elite of the army) suffer less than the infantry, and they again, greatly less than the hard-labouring and ill-fed camp follower. So also it is as constantly found that the bramin (the supreme or

priest-caste) and the sleek banian (merchant) suffer less than the ryot, who pays often as much as half the produce of his rice-fields to government for rent, and extorts from them a scanty subsistence under a burning sun; and still more remarkably less than the poor outcast pariah, who carries a burthen ten miles, and returns the next day empty-handed for five pence sterling.

The greater prevalence of the disease among soldiers, both native and European, than their officers, has been from the first generally remarked. Thus during the first attack at Bellary, not an officer out of at least fifty at the station was attacked. In the severe attack of the 34th, not more than two slight cases occurred in a body of about thirty officers, whilst of the men, one in eight were admitted into hospital, and many died. In the first and very severe prevalence of the disease in the field force in the Dooab (General Pritzler's), not more than two or three attacks occurred among the officers of the whole camp. In the Candeish field force not one, though one of the corps suffered severely.

In the centre division of the Bengal army too, Mr. Jameson states: "during the week in which the epidemic raged with so much fury, when the camp was a sick ward, and every tent was filled or surrounded with the dead or dying, the officers suffered comparatively very little. From a number that could hardly have fallen short of three hundred, only five or six deaths occurred; and it should be remembered, that at this time officers of all descriptions were equally exposed with the medical men, for the sick had become so numerous, that even the services of all were insufficient to tend them with proper care, and duly administer the requisite remedies." Mr. Marshall states, that in his experience (in Ceylon) the commissioned officers were entirely exempted.

In this circumstance, however, there is nothing peculiar to cholera. Commissioned officers are generally much more

healthy than at least *European* soldiers. This is particularly remarkable with regard to the dysentery, or the particular inflammation of the large intestines, which destroys probably at least one-half of the Europeans who die in India in ordinary times, and in those parts where malaria does not exist in any notable degree, a still larger proportion. From this disease officers are almost exempt, even when it is prevailing as a most virulent epidemic, as it often does in standing camps in hot weather. I have treated thousands of cases of it in soldiers, in these and all other usual situations, but never saw an officer die of it, and rarely a serious case, or an attack of it at all among them. This I have never ceased to wonder at, and in seeking its explanation have sometimes been tempted to refer the disease to contagion, for the officers do not, of course, frequent the common privies. They are not so remarkably exempt from hepatitis. It is, however, chiefly referrible to the greater regularity of life of the officer; for though he takes a considerable portion of spirituous fluids, it is regularly and without inducing intoxication, whilst the soldier will be partially intoxicated for a week or two together; and then, having no longer the power of inducing that state — which is with him the summum bonum — he reverts to his water-drinking till the next receipt of pay, or till he has hoarded up the means of renewing the excessive stimulus. The prospect of sickness or even death have no terrors for him to keep in check this inordinate appetite. And to this circumstance we must chiefly refer the greater prevalence of cholera in the European soldier than the officer. The former is sufficiently clothed and fed, and his frame is generally somewhat robust; there is, therefore, no predisponent debility to account for it. Other circumstances also doubtless contribute to produce the superior general healthiness of the officer, as his greater general care of his health and attention to its first derangements; and particularly the greater influence of mind, and the amusement which

it creates; for ennui and inactivity of mind, as well as of body, are a great cause of disease, and nowhere so remarkably as in hot climates.

The greater prevalence of the disease among the sepoys than their European officers, which is as remarkable as in the other case, is to be placed to another account. They are perfectly temperate, as are almost all the natives of India, but this temperance is with many of them perforce carried to excess. It is evident that the greater liability to this epidemic of the sepoy than his officer, and indeed of the natives in general, compared with the Europeans in India, is owing to a diet not sufficiently nutritious to ward off the attacks of a disease which is so eminently one of debility, although it is undoubtedly better calculated than ours to obviate the commoner form of Indian disease, pure inflammation. The pay of the sepoy is about five pence per day, and on this most of them have families as well as themselves to maintain. Yet this is affluence compared with the situation of most of the inferior servants, grooms, tent-men, porters, &c. who receive not more than from half to two-thirds of that sum, and they again are objects of envy to others unemployed and still lower in the scale. Neither are the prices of the necessaries of life proportionably low. The general diet of the lower classes, is rice or other grains, boiled whole or made into cakes, the insipidity of which is in some degree removed by a sort of thick soup composed of vegetables, and a great proportion of condiments; and this food is too often also deficient in quantity. No wonder therefore that we should find so abundant a predisposition to the disease existing among a people thus dieted, and that it should be so often excited into action by exposure to cold and moisture in their wretched huts, or the still more wretched substitutes for tents of the innumerable followers of a camp.

The mounted troops are also found to be less liable than the infantry to other diseases as well as to cholera. Their general healthiness is well known, and appears to arise from

their being better behaved men, and of better constitutions, and also from their having a constant light occupation about their horses. When the disease first prevailed at Jaulna, a brigade of horse artillery there almost entirely escaped; and at Hansi in Bengal, the complete exemption of a cavalry corps is particularly noticed. A similar exemption of two cavalry corps is likewise stated at p. 11 of the Bombay Report. But without looking for further proofs of this fact, I will merely state that of the thirty-four instances which Mr. Scot details of attacks of cholera in marching corps, there was only *one* of cavalry; whilst of the twenty-six innocuous marches, *seven* were made by cavalry. In one of these instances the march was made in very bad weather, which appears to have been particularly mentioned to show the harmlessness of that condition of the atmosphere; in another, the camp-followers are stated to have suffered whilst the troopers escaped; and in a third, the exemption was still more remarkable, for the corps was marching in company with an infantry corps which was suffering severely. And these escapes are not to be attributed to the trooper undergoing less fatigue than the soldier, for the labour of the former in cleaning and taking care of his horse is fully equivalent to the saving of it from riding. Even the light company of a corps has been found nearly to escape, whilst the corps itself (the 14th regiment at Merut in 1819) was suffering severely, and almost exclusively, in the midst of a large cantonment. That company is always composed of *picked men*. Mr. Jameson says: "The bearer and khulasee generally, and with the artillery the drivers and men of the magazine establishment, were attacked in much larger proportion than the regular soldiers, because they were inferior in strength to the sepoys and goolundaz, had no tents, received less pay, and were worse clad and fed *." All these and many other facts which might be adduced, show that often apparently trifling and almost imperceptible differences in the general

* Report, p. 153.

susceptibility of a body or class of people, are sufficient to determine a most afflicting prevalence of the disease, or an entire exemption. And it is perfectly evident that a particular susceptibility or predisposition, whencesoever it arises, is often almost *every thing* in the production of the disease, whilst all the other agents, however powerful, whose operation is more direct, as contagion, the great meteoric influence, exposure to cold and wet, common errors of diet, &c. fall almost to zero in its scale of causes.

There is, however, too much evidence to show that bodies of people at times thus favoured, have not been equally fortunate on subsequent occasions. It was during the first year of the prevalence of the disease on the peninsula, that the immunity of military officers was chiefly remarkable. Since that time the public journals have been full of accounts of their deaths from cholera, and those of the civil officers of the Company. Dr. Daun states, that on marches "even European officers cannot entirely escape the influence of the causes of the disease, and we accordingly find, that of the number who have fallen victims to the epidemic, all, or almost all, have been attacked whilst marching from station*." Mr. Jameson remarks, that "in Mymensing in 1817, the attacks were observed to occur chiefly in the lower classes; but in 1818, neither caste, age, nor sex, were spared; and in September, October, and November, the mortality was frightful. At Bulloah, and the whole south-west division of Tipperah, few survived without medicine, and it is estimated that a tenth part of the whole population disappeared."

In the second attack on General Pritzler's force at Gudduck, the officers who had escaped before suffered very severely. The horse brigade too, which has been mentioned as having escaped at Jaulna, suffered even more than the other troops on a subsequent attack. These facts evidently correspond to those of the epidemic on its second visits reaching the more healthy parts of a country — climbing the mountains, &c.

* Hawkins on Cholera, p. 268.

They seem to show that the virus had acquired additional power, and was able to take effect with less degrees of susceptibility than at first.

There is reason to believe that the vigour of constitution which Europeans possess on their arrival in India, makes them less susceptible of this disease than others longer resident in it, who have been debilitated by its diseases, and have suffered the gradual impairment of the constitution which is made by the excessive heat. When the 34th regiment underwent their severe attack, there was incorporated in it a large body of recruits, who had been less than six months in India, of these one in eleven and a half was attacked, whilst of the rest of the corps, who had been much longer in the country, one in seven and a half was affected. The relative mortality was nearly equal in both, *viz.* the very high ratio of one death to two and a half attacks.

The proportion of persons susceptible of this disease appears happily to be small in comparison to those who suffer when exposed to the full influence of the causes of the plague, yellow fever, and other epidemics. It seems however to be so very variable as to set at defiance all attempts to estimate its amount. In Mr. Scot's marching corps (chiefly natives) the number of attacks varied from seventeen to three hundred and thirty per corps of about one thousand men, being on the average about twelve per cent. And even on the first spread of the epidemic the variations appear to have been equally great. In fact, as we have seen, the severity of the prevalence is always greatly influenced by various external circumstances. For example, one corps getting through the disease with a fine clear sky (if it is susceptible of it at all under the circumstances) shall suffer very little, whilst another under the opposite circumstances shall suffer severely. But if these two corps encounter the disease afterwards together, and in all external respects perfectly similar, the latter (having its susceptibility previously exhausted) shall suffer slightly, whilst the former suffers severely. This has been proved by experience

to be the case. But perhaps the number of attacks which occurred in the 54th and 41st regiments, on their landing at Madras, may give some idea of the proportion of susceptible among European soldiers in ordinary circumstances, as they underwent at different times the general attack which bodies of people arriving in India, since the origin of the epidemic, have probably always experienced, and generally soon after their landing, particularly as they are nearly equal. They were, in the first corps 23½ per cent. of the strength, in the latter 22. The former corps lost every third man attacked, the latter every fifth*.

It is difficult or impossible to define clearly the conditions of the system in which this perilous susceptibility consists. Some of their leading features are however sufficiently marked. A degree of debility and laxity of the frame, whether it arises from idiosyncracy—or from insufficient nourishing food—or from fatigue or exhaustion of body or mind—from excessive heat or previous disease, or the various other causes which may produce it, appears to be the principal morbid or morbific state. Another is found, often indeed a concomitant of the former, in that irritability of the system, and general tendency to disease, whether it is inherent (or rather arising from unknown causes) or owing to intemperance, &c., which so often exists, and is continually ready to put on any form of morbid action, which contagion or other exciting causes may determine.

But with all the lights which the most attentive consideration of the subject could afford, let the surgeon of a corps—the most experienced of that useful body of men—on its arrival in India, select all the members of it whom he considers susceptible, for the employment of prophylactic measures, how many of his *marked men* would be passed over by the disease, and how many more would it single out whom he

* Madras Report, p. 24.

never suspected of predisposition! How often have we seen persons of the most robust and healthy habit, and the last whom we should expect to be obnoxious to cholera, seized by it, even when it was not prevailing to any considerable degree, in its very worst forms! Doubtless the disease found in them some congenial diathesis, some hidden flaw in the constitution, by which it was enabled to make its fatal invasion.

It is uniformly observed that this disease, in its general attacks, has a constant tendency rapidly to wear itself out. Thus in a corps, no sooner has it attained its maximum than it begins to subside, and usually shortly ceases. Often indeed it fluctuates, dying away, and again suddenly springing up, as we have seen, from evident causes; but under whatever circumstances of external influence (excepting highly malarious situations), it soon finishes its course, or is reduced to its straggling, "sporadic" form. Again, we observe that it will not retrace its steps and spread back through a country it has just ravaged, any more than a conflagration in a grassy plain, but still pushes on among fresh bodies of people*. It

* Whoever has seen the dry grass and brushwood on fire in a wild part of India, in the burning month of May, or in any similar situation, can be at no loss for a lively picture of the progress of the cholera. The conflagration is seen from a distance, advancing over the country in an irregular line, blazing up with fury, and advancing more rapidly when it meets with abundant fuel and is favoured by the wind, and appearing to die away when it reached a bare tract—but still creeping on. Diverted here and there from its course by some accident of a brook, a lake, or a bare hill, it leaves patches untouched for a while, but sooner or later the flame, by some hidden or circuitous track, reaches them too, and equally destroys every thing they contain susceptible of its influence. Before it the wild animals are flying in terror, behind is a black smoking expanse of desolation; which, however, in a few days, if favoured by rain, is covered with luxuriant bright green vegetation, and the appearance of the country is *wonderfully improved* by the accident. But woe to the camp or the tent that is surprised by this wild-

is evident, therefore, that it quickly seizes on all that are susceptible of its influence—that the great mass are invulnerable to it—and that those who have suffered its attacks and escaped, have gained a similar immunity, else it would, under some favourable circumstances, continue to attack them again and again, or turn back to them, until it had destroyed them all. Accordingly we find, on the clearest evidence, that such an immunity is actually conferred on the subject by an attack of this disease.

Little attention appears to have been paid to this point on the Madras Establishment. It is nowhere mentioned in the body of the Reports, except in one instance, where an officer, after a short and limited experience of the disease, states that one attack is no protection against a second, as he had known several instances of succeeding attacks; and Mr. Scot in one sentence maintains the same opinion, but without adducing any facts in support of it. Relapses are indeed not uncommon, but rarely I believe in the original form; and after complete re-establishment, the protection that is gained, for a time at least, is very evident. For the establishment of this fact we are indebted to Mr. Jameson and the observers in Bengal.

"An individual having once undergone the disease, thereby became much less subject to be again attacked, than a person who had not passed through the same previous seasoning. It is not by this meant to be asserted, that relapses did not sometimes occur in persons who had not perfectly recovered from the effects of the first attack, nor even to deny, that in some rare instances the disease recurred at long intervals, when the individual had entirely regained his strength. All that we intend to affirm is, that such cases were exceedingly uncommon. To many of the medical officers who possessed

fire without its *cordon sanitaire* of cleared ground (the grass pulled up in a circular line) around it! The canvas is reduced to ashes in a few minutes, and few and sadly scorched are the rest of their goods which they are able to snatch out of the flames.

large opportunities of observation, it did not occur to observe a single instance. Thus the centre division of the army hardly affords half a dozen instances. * * * * In the left division and Rajapootana force, according to the unanimous declaration of the medical staff, no case of re-seizure occurred after the strength had been fully restored. In the Nagpore force, two or three instances came to notice, but all came under the strict denomination of relapses, for although the individuals had recovered from the primary shock, a long enough interval from the first attack had not been allowed for the complete restoration of their strength. The most decided case was that of an European, who had been twice attacked whilst under the influence of mercury, and had so far recovered as to return to his duty, when after the lapse of five or six days, he got the disease a third time and died. With the Kuruaul division not a single case offered. The same immunity from secondary visitation was observed in every quarter in which the epidemic prevailed, and we should perhaps not be far wide of the truth were we to affirm, that of the many myriads attacked, the returns of the whole country do not afford a score of well authenticated cases of a recurrence of the disease, after the removal of the debility and every other consequence of the primary attack.

" Another curious circumstance in the economy of the disease was, that not only were persons who had once undergone its attack free from its further assaults, but even individuals and bodies of men, who having come within its pestilential influence and had escaped unaffected, were nevertheless much less obnoxious to its future visits, than those who had not before been exposed to the virus. In other words, a village which was visited by the epidemic during the first year of its prevalence, would on the disease re-appearing in that part of the country, be much less likely to suffer than another village which had not before been affected; and an individual going from the former into the infected air of the latter, would have a better chance of immunity than its inhabitants, who had not

undergone the previous seasoning. This was the case, to a greater or less degree, in every part of the provinces; in which it was generally remarked, that the epidemic on its recurrence either did not at all revisit the places formerly affected, or only in a much lighter manner than those to which it was yet a stranger. In Tirhoot particularly, in which the epidemic twice appeared at two distant periods, the truth of this observation was strikingly illustrated, since, according to the observation of a very intelligent observer, not a single instance occurred of the disease revisiting the same place throughout the whole extent of the district.

" But it is in the different divisions of the army, the bodies composing which remain under the eye of the same medical officers, that we should expect to find the existence of this law most clearly established. It is here accordingly that we have the best examples of its reality. Thus in the Jubbulpore force, the 7th regiment of cavalry, and 2d battalion 13th native infantry, which corps had suffered severely in November, with the centre division and at the Bridge of Boats, remained quite exempt. Thus too, the 2d battalion 19th, which was violently affected by the disease in August, had only three slight cases in September, when the other corps of the Rajpootana force were so roughly visited. But the best illustrations are to be found in the centre division. When this force broke up after the termination of the campaign, His Majesty's 24th regiment of dragoons, and 87th regiment of foot, and the 1st battalion 8th regiment native infantry marched to Cawnpore, where they were stationed in April and May, when the city and cantonment were suffering from the disease. At this time the 24th dragoons remained quite free; His Majesty's 87th had two slight cases, among the recruits who had not been with the centre division, and no death; and the 1st battalion 8th regiment native infantry, had according to one statement no case, according to another only one, and according to a third, three or four, all slight attacks. The situation of the latter corps was such as

to give additional proof of the immunity of bodies previously exposed not being accidental; for it so happened, that this battalion was placed right between the 2d battalion 15th native infantry and Craigie's levies, both of which suffered severely, as not having earned the same means of protection. Camp-followers of all descriptions were equally exempt, and one person only, who had been with the centre division, an European officer, fell a victim to the disorder. In like manner the 2d battalion 25th regiment native infantry, which again fell in with the disease in April, whilst marching from the Tiraee for Lucknow by Gorruckpore, then suffered comparatively little. It had indeed twenty-five cases and five deaths, but of these only one was a case of relapse or recurrence, and even in it, the symptoms of both attacks were very mild. But a still more extraordinary instance occurred in Lord Hastings's camp, during the march to Gorruckpore, towards the latter part of the same month. The disease here first broke out among the followers of a gentleman, who had just joined the party, and in a few days attacked between fifty and sixty out of four hundred, chiefly of the class of bearers. It next got among the servants of several gentlemen in the civil service, then in attendance upon the Governor General, and to the period of its decline was confined to such persons as had not been with the centre division. This could not be explained on any difference of situation, for the party daily changed ground, and the new comers were mixed promiscuously with those who had been previously exposed to infection. Nay, it further appears, that after attacking the first party, the disease made a long stretch, and next showed itself amongst other persons not yet seasoned in the opposite end of the line, leaving all between untouched. If any proofs were necessary, we might cite the case of the 2d battalion 3d regiment, the greater part of which having had the disease at Shergurh, were not all affected, although stationed at Banda when the town suffered severely. But enough we think has been already said, to show that the human frame on

being exposed for some time to the pestilential virus, got habituated to it, and in a great measure became insusceptible of its malignant influence." To this complete evidence I will only add the instance of the Topaze frigate, which conveyed the cholera to the Mauritius. She had got through the disease on the voyage, and consequently had not a case in harbour there, when all the other ships were suffering from it*.

We have besides the continual recurrence of this fact of the immunity enjoyed by persons who have been exposed to the causes of the disease during its prevalence, and either have or have not taken it, in the attacks which generally happen to bodies of men landing in India soon after their arrival, and reaching them alone though mixed up with other troops. These instances are brought forward in arguments against the contagiousness of the disease, but they are clearly explicable on the grounds stated, as are some others somewhat different. The 34th regiment was encamped at the Mount, near Madras, in 1823, for the purpose of volunteering preparatory to embarkation for England; that is of allowing the men desirous of remaining in India to transfer themselves to other corps—a permission which seven-eighths of them accept. In consequence, apparently, of the excessive heat of the tents, and the great drinking attending the volunteering, a high degree of susceptibility to the disease was reproduced in them, which appeared to be excited into a severe epidemical visitation by a slight change in the weather†. At the same time the disease was not prevailing in the fixed troops at the same station, nor anywhere in the neighbouring country, except in the 54th regiment, just arrived in India, and in the 53d, on its march. Whilst the disease was prevailing in the 34th, a party of volunteers left it for the depôt at Poonamalee, eight miles distant. In the course of a week after their arrival there twenty cases occurred in that party,

* Report of Dr. Kinnis, to the Army Medical Board.

† See the Report regarding this attack in the Appendix.

but not one in the various other parties of troops previously there, though they were all mixed up together. These facts are however perfectly analogous. That little party was in the same situation as the 54th at the same time at Madras, with but this difference, that its susceptibility was owing to excessive heat and continued intoxication, whilst that of the newly arrived corps was the original stock which exists in every body of people before being exposed to the disease. The 53d regiment shortly after underwent their volunteering in the same neighbourhood, under the same circumstances with the 34th, of exposure to heat in camp and intoxication, yet escaped the disease. And this is mentioned, apparently, as one of those contradictory facts which are to cut short all further inquiries into the causes of this "inscrutable" disease. But on the foregoing principles how perfectly evident is the cause of the exemption: the 53d had but two months before undergone a severe visitation, induced by marching and atmospheric influence, by which its susceptibility was exhausted, and the causes which proved so fatal to us were insufficient to reproduce it in them*.

The short duration of the prevalence of the disease, however violent, in any body of people, particularly a small and condensed body, who are quickly all exposed to its contagion (which may be set down as one of its strongest characteristics), appears clearly to be owing to the disease being enabled, by its rapid mode of diffusion and its short latent period, quickly to bring under its influence all the susceptible, and either to destroy them or render them unsusceptible, whence its pabulum

* Instead of attentively examining and comparing the numerous facts on record regarding this most interesting etiology, which thus support and illustrate each other, some persons (who have never seen the disease) will glance at the conclusions drawn from them by others, who have devoted all their energies to the subject, and conceiving them improbable—in a spirit equally remote from charity and philosophy, and precluding even the common amenity of language—will pronounce them "RIDICULOUS, and unworthy of attention or refutation."

being exhausted, it necessarily expires. We are, therefore, continually drawing wrong inferences of the causes of the disappearances of the disease, when we find them coincident with change of circumstances, as change of situation or alterations in the state of the atmosphere.

These changes doubtless have great influence, but it is evident that the disease has a natural tendency to a quick and spontaneous declension, independent of external change. The same observation may be applied to another of its striking features, the change of type which almost uniformly takes place in the course of any of its separate visitations. Thus, it is constantly observed, that the first cases are almost all of that low, asthenic, "foudroyant" form, which place the weakness of the medical art in a very strong light. The powers of life appear to be overwhelmed and to sink at once, without exhibiting their ordinary efforts of resistance, as if they were simply arrested by a highly sedative poison. But happily this fatal form of the disorder soon almost disappears, and is replaced by that milder type, where the resisting exertions of nature are so conspicuous in the form of various increased actions, and which, in our Indian experience at least, has commonly been found one of the most tractable of acute diseases, in wonderful contrast with the former. These circumstances have already been long ago dwelt upon, but on points of such importance repetition may be pardoned. This metamorphosis of the disease (if so strong an expression is admissible) has also been attributed to various external changes; but it is of too constant occurrence, and generally bears too evident a relation to the beginning and end of the general attack, to be thus accounted for. It is evidently owing to the disease being developed the first, and to the highest degree, in the most susceptible; whilst the stronger and healthier frame, if it is not entirely invulnerable, is invaded the last and suffers the least.

But this order is sometimes reversed, probably from atmospheric influence or other causes. For example, at Vizianagrum, for the first month, the disease, "though formidable

in appearance, *invariably* yielded to treatment; but during the next fortnight the low, quiescent, and delusive form prevailed, and proved fatal to numbers, both of those who applied early as well as those who did so at a later period*." No mention is made of the weather, but it was on the 20th of June, when that great change in the atmosphere that attends or precedes the setting-in of the rains generally happens, that the change of type took place. So at Nellore, it is remarked: "I observed, that on its first appearance the symptoms were mild, and after seven or eight days continuance, it seemed suspended for five or six, when it recommenced with increased violence. Previous to its disappearance it again became milder, and fewer casualties occurred†." These fluctuations must have been chiefly owing to atmospheric influence. They are very similar to those described and traced to that cause by Dr. Scott at Madras.

It is probable, that many who are insusceptible of the disease in any full and defined form, do yet actually suffer it in a minor and partial degree, to which the term cholera, from the symptoms, would never be applied. I have already mentioned several instances, where various partial disturbances of the health, as different disorders of the digestive organs, general malaise, &c., were almost universally complained of, during the severe visitations of the epidemic in India. And Dr. Kinnis reports, that in the 56th regiment at Mauritius (in 1819), "No children, and but a very small proportion of females were attacked, but convulsive affections resembling hysteria were unusually frequent among the European and mulatto women belonging to the regiment." Dr. Burke, in his report on the same occasion, likewise notices the general prevalence of colics, diarrhœas, &c. together with the epidemic. It appears that similar occurrences have been observed in Russia. A physician at Orenburg states (in the Russian Official Reports): "During the prevalence of the epidemic, there was scarcely a single inhabitant of the city of Orenburg, who had not some symptoms of disordered digestion.

* Madras Report, p. 32. † Ibid. p. 41.

One complained of oppression and pain in the breast; another of headach, slight nausea, diarrhœa, and the like; and this was especially remarkable in persons arriving at Orenburg. These trifling symptoms of disease were usually ascribed to errors of diet; but to me it appears, that their cause was a general invasion of the system of cholera, which however was prevented from developing itself in its perfect characters by a regular manner of living, and other circumstances of the kind." Dr. Joenichen also observes: "The invasion of cholera in Moscow and elsewhere in Russia, was preceded by a particular disposition to diarrhœa, vomitings, &c., which continued throughout the whole of the disease, and which seems to prove the existence of a particular epidemic state of the atmosphere." At Orenburg also, these slight affections were attributed solely to the atmospheric cause of the disease, but it is at least as probable that they have arisen from contagion, in combination with more or less of that cause. Mr. Jameson states (Report, p. 67): "In one case, that of a gentleman who died after six hours' illness, the three medical men who opened the body were sensible of a peculiar offensive odour, very different from the ordinary smell of dead bodies, and all were for a day or two affected with vomiting, looseness, and other symptoms of disordered bowels."

It has been very generally observed, that Europeans in India have been less subject to the epidemic than the natives; but that conclusion seems to have been chiefly drawn from comparison of the latter with the military and civil officers, and other Europeans of regular lives, who are scattered over India. It appears very distinctly from the returns of the Madras army, that the intemperate soldier, in spite of his more robust frame and better diet, has suffered more than the sepoy, with all his predisponent debility.

The following table, constructed from one in Mr. Scot's work, will show the fact, and also another remarkable one, that though the relative number of attacks was greater in the Europeans than the natives, their proportion of deaths to cases was less.

TABLE OF ATTACKS AND DEATHS OF CHOLERA IN THE MADRAS ARMY FOR FIVE YEARS, viz. FROM 1818 to 1822 *.

	Average Strength.	Total Number of Attacks.	Total Number of Deaths.	Proportion per cent.		
				Attacks to Strength.	Deaths to Strength.	Deaths to Attacks.
Europeans.....	10,112	3,664	696	36	6¾	19
Natives.....	71,234	15,830	3,735	22	5¼	23½

It is evident, however, from the remarkable immunity enjoyed by the European officers, &c., that the natives of India

* The following summary, extracted from the critique already mentioned of the Edinburgh Medical Journal, on the Russian Reports, will enable the reader to compare the mortality of the present epidemic in Russia with that of the disease on the peninsula of India. "In Astrakan, one third of the cases died; in the government of Kostroma, rather less; in Nishni-Novogorod, one-half; in Casan and Moscow, three-fifths; in Penza and the country of the Don Cossacs, two-thirds; and in the whole of these places taken collectively the number afflicted was 14,000, and the deaths 7,700, so that the total average mortality throughout the invaded districts may be safely assumed to have been one-half. The mortality in Moscow varied greatly at different periods of the epidemic, being at first as high as nine-tenths, and sinking afterwards gradually to seven-eighths, five-sixths, three-fourths, and a half, and at last to one-third." The last would have been a high rate of mortality on the Indian peninsula. It was observed that the mortality of the Orenburg epidemic was much less than the present one, derived from Astrakan, being on the average about one-fourth, which (as will appear from the table) is but a fraction greater than that of the Madras army. There is considerable probability that this branch of the epi-

have possessed no advantage in that respect over Europeans, from being in their own climate. They also suffer from the malaria fevers (at least the intermittent form) equally with Europeans, and very differently from the negro race, not only in Africa, but in all parts of the world. A considerable number of the latter people, descendants from slaves imported from Africa by the Portuguese, exist on Ceylon, and a corps in the British service is formed of them. Mr. Marshall states the remarkable fact, that these persons, though almost entirely exempt from fever, suffered from the cholera equally with the natives; and the negro slaves were not more fortunate at the Mauritius. It may be inferred that they were insus-

demic was derived directly through Tartary from the north-western parts of India. It would be highly interesting to ascertain if such was the fact, for if so it would account for the difference of type which it exhibited from that of 1830. An instance has already been related of a form of the disease, characterized by extraordinary depression and fatality, being transferred from a corps to a population among which it arrived.

It appears that the mortality from the disease in the native part of the Madras army was about 5¼ per cent. for the first five years, or one per cent. per annum. Assuming this as a measure of the general mortality, and taking the population of the continental parts of India at sixty millions, the mortality from the epidemic in India for these years will amount to three millions; but this is probably within the truth, for two reasons, — the disease was much milder in the healthier climate of the peninsula than in Bengal, where it originated, and it has been generally observed that the sepoys suffered less from it than the general population. Much of the mortality in the army was certainly owing to marching, but perhaps an equal proportion was produced by the journeys of the rest of the people.

During the present summer the mortality of the cases appears to have been upon the whole greater than in the preceding; being, according to the Berlin State Gazette, at Petersburg, Riga, Mittau, Lemberg, and Brody, about one-half; and at Dantzic, Elbing, and Posen, about two-thirds. The disease in general often presents the remarkable fact of the proportion of deaths to cases being in the inverse ratio of the latter to the population.

ceptible of the influence of malaria, but not of the contagion of cholera. And that single fact shows, as well as a thousand could do, that however much malaria may have conduced to the production of cholera, something must be superadded to it to produce this epidemic. In perfect agreement with these observations, it is found that the negroes in Egypt suffer equally from the plague with the rest of the population.

The various periods of life have been found to be distinctly marked by various degrees of susceptibility. Very numerous observations seem to establish the general fact, that that fatal property is pretty constantly in the direct ratio with the age of the individual. Thus it has been constantly remarked, that infants at the breast are scarcely ever attacked*, children rarely, and young adults in the first vigour of life are certainly much less subject than the middle-aged, though scarcely past their prime. The old are, *ceteris paribus*, by far the most subject of all. Sex has also had considerable influence, though perhaps less generally than age. It might have been expected that the female, from her weaker frame, would have been more susceptible; but, whatever is the reason, it appears that the reverse has commonly been the case. This inference is drawn by Mr. Jameson. He states that it appeared from returns of attacks in the native inhabitants of the suburbs of Calcutta, the proportion of males taken ill was to the females as four to one. In Dacca, and in a bazaar at Merut, it was two to one. In Tirhoot, it was generally remarked to be greater; and the observation has been confirmed by Dr. Marshall on Ceylon, by Dr. Scott at Madras, and others on the peninsula. But at various other places women have been found to suffer equally with men; and Mr. Scot sets down pregnant women as particularly sus-

* Mr. England, in stating this fact, observes that the same thing has been found to happen with the plague, and ingeniously adduces the experiments of Dr. Priestley, showing that young animals live longer in noxious airs than old ones.—Rem tetigit acû.

ceptible *. Debility from other diseases has been commonly observed to predispose to cholera. Convalescents in hospital are often attacked; and Mr. Jameson mentions an instance of a corps which had previously suffered severely from fever, having also suffered in an extraordinary manner from the cholera.

The observations that I have to offer on the exciting causes of the disease, may be comprised in a few words, as they are generally very obvious. Insolation, and exposure to cold or moisture, may be considered as their principal; and it should always be remembered that such exposures are particularly dangerous during sleep (itself apparently an exciting cause of the disease), and during journeys, when we are so much more liable to them than in other situations. And it will be evident from the foregoing statements, that a journey (independent probably of exposure) during the prevalence of the epidemic will be attended with very considerable danger of inducing an attack. Intemperance in drink has already been strongly adverted to, but the fact of its great influence in producing the disease cannot be too much insisted on. The relaxation and depression of the nervous energy which follows that stimulation must be, of all conditions of the frame, the most favourable to the invasion of the disease. Intemperance in food, by deranging the digestive organs, and through them the whole frame, is doubtless a great predisposing or exciting cause. The disease has often been observed to make its

* It was found that in Bengal the disease — true to its principle of attacking chiefly the lowest classes — was particularly prevalent among the abandoned class of women. Well might the Chinese observe that "the pestilence knew its victims;" and, however the philanthropist may be shocked at the immediate calamity which marks its footsteps, he cannnot entirely condemn their mode of reasoning regarding it; that in an over-populated country, it is not a curse but a blessing; for it deprives of life chiefly those to whom it is of least value, the wretched, the sickly, the aged, &c., and very commonly those who are of the least value to the rest of society.

attack after a meal, and particularly after the wretched breakfast common among the lower classes of the natives of India, cold rice, with the water in which it has been boiled for drink*. It has so often been observed, both in Bengal and

* The following directions issued by the Russian Government to the people on the approach of the epidemic, form probably as complete a brief code of instructions against its exciting causes as could be constructed.

1. To avoid sudden chills as much as possible, and *on account of the bad weather at this time of the year*, to take care to be more warmly clad, and more attentive to the strength of shoes and stockings; to change instantly the clothes which have been wetted by the rain, and to keep the feet always dry.

2. Never to sleep in the open air by day or by night, and particularly not on the damp ground.

3. Not to load the stomach with too large a quantity of food, and especially of indigestible food. It is rigorously prohibited accordingly to eat apples, plums, melons, water-melons, cucumbers, raw turnips, carrots, mushrooms, and other vegetables of the same sort.

4. To make as little use as possible of strong drinks, and of a heating diet, and particularly to abstain from garlic.

5. To take the greatest care to keep the body very clean, to change the linen as often as possible, and to maintain the utmost cleanliness, not only in the apartments, but also in the courts and the streets.

6. Never to leave the air pent up in the apartments. For this purpose the windows must be opened when the weather is fine, and during rainy and damp weather the stoves must be lighted, and the room perfumed with vinegar and spirit of juniper.

7. Never to go out in the morning with an empty stomach, and not to fatigue oneself to exhaustion with daily labours.

Nos. 8, 9, 10, 11, give directions for *immediate* application for medical aid on being attacked, separation of the sick, &c.

12. The authorities of the government, founding their confidence on the assurance given them by medical men, who have carefully attended to the progress of the disorder, inform the citizens with certainty, that they will be preserved from its attacks if they conform themselves exactly to the directions above laid down. A very important means of safety is to repress all tendency to depression and chagrin, and to preserve a cheerfulness and tranquillity of mind.

the peninsula, that persons in the state of ptyalism from mercury have been particularly subject to the attacks of the disease, that there can be no doubt of the generality of the fact. It has also been often remarked, that the attacks have followed immediately on taking a dose of the neutral salts; but it is probable that the disease has previously existed, and that the indisposition of its first stage has led to the use of the medicine.

SECTION VII.

COMPARISON OF THE EPIDEMIC CHOLERA OF INDIA WITH THAT OF EUROPE, AND GENERAL OBSERVATIONS.

No reasonable doubt can now be entertained of the identity of the Indian cholera with that which prevails at present in Europe, but it is highly interesting to inquire whether any, and what modifications have taken place in it during its long course from the mouths of the Ganges and Megna to Vienna and Berlin; in which it must have encountered every possible variety of constitution and mode of life in its victims, and of climate and locality; to examine if its symptoms and mortality are altered — if its contagiousness is diminished or increased — if it is still equally influenced by or dependent on atmospheric causes and situation;—and in general, if its laws continue the same under that extreme alteration of circumstances. On these points, the information I possess on one side of the subject is extremely defective, and therefore the remarks I have to offer, must be, at least at present, few and desultory.

In the first, second, and third stages of the disease, that is, the incipient stage — the mortal struggle — and the quiescence or general paralysis of organs that succeed *, which have been termed collectively by others the *cold stage* of the disorder, or the state of collapse — in these no remarkable difference is apparent between the European and Indian epi-

* This stage has been generally unnoticed in descriptions of the disease, but it is particularly remarked by that most acute observer Hippocrates. He states, that if the coldness and extreme debility continue *after the cessation of the vomiting and purging*, the case is mortal. — Parr's Dictionary.

demics; but in the febrile state which follows, both in favourable and unfavourable events, when death does not quickly close the scene, one considerable feature of difference, at least, is evident. This state has appeared to me in India to exhibit itself under two distinct forms; the moderate febrile reaction of the system, with general increase of the secretions, unattended by remarkable local affection or extreme debility; and a typhoid fever of the very lowest type, which, as far as my experience has extended, has always appeared to be symptomatic of inflammation, generally of the stomach, intestines, or brain. The former was the usual mode of termination of the disease in health, the latter was rarely recovered from. Unhappily it appears that the former has been much more rare in Europe than in India, and the latter, or some state highly resembling it, exceedingly common; and hence chiefly appears to have arisen the excessive mortality of the disease since it has entered Europe. Dr. Kier finds, that of twenty fatal cases, seven terminated in the cold stage, and thirteen in the hot stage. Whether that fatal affection has commonly assumed the idiopathic form, constituting typhus or pestilential fever, or whether it is still referrible to inflammation, appears to be somewhat uncertain. It is however very evident that inflammation was, very generally if not invariably, one of its most prominent features. Drs. Russel and Barry state that it is attended by soreness on pressure on the liver, stomach, and belly, delirium and stupor. Mr. Searle finds it at Warsaw "of a bilious *inflammatory* character." Dr. Keir observes, that at the abatement of the disease, in its cold stage, the patient generally sleeps. "This favourable change comprehends the second period, that of reaction. A febrile state, more or less distinctly marked, now takes place; and lucky is the case when it is moderate, for such generally recover. The secretions, which were suppressed in the first period, now begin to reappear; a gentle perspiration sometimes takes place; urine is discharged frequently, more or less tinged with bile, and the stools chiefly

consist of bile in a very vitiated state." This is precisely the "stage of reaction," such as I have described it in India. Dr. Kier continues:—"Much more frequently, however, a second ordeal now begins, sometimes as severe and frequently not less fatal, though more slowly so, than the first. This is probably the effect of the morbid changes that have been induced during the first period of the disease. The appearance of the complaint is now entirely changed, insomuch that one who had not seen the patient during the first period, or been told of the symptoms, could not possibly know that he was suffering from the epidemic. I have observed the disease, in this its second period, to assume four forms; the first an inflammatory fever, or rather sub-inflammatory state of the stomach and bowels, most frequently the latter, sometimes conjoined; the second, inflammatory irritation of the lungs, with pain of the chest, cough, viscid expectoration and fever, appearing as a critical metastasis of the disease; the third, bilious or bilio-nervous fever, with suppuration of the parotid glands, in one case with suppurating axillary bubo towards the end of the fever, and inflammatory irritation of the lungs ending in vomica; and the fourth, a congestive sub-inflammatory state of the brain and spinal cord. This last, as was natural to expect from the nature and seat of the affection, proved by far the most dangerous and most frequently fatal form of the second period. It appeared generally to supervene after the purging, vomiting, and cramps had been relieved, and the external heat in some degree restored. The patient complained of pain in the back, between the shoulder blades, or in some other part of the spine, sometimes along its whole tract. He appeared sleepy to such a degree, that at first I was disposed to attribute this state in part, at least, to the effects of the opium given in the first period. But I was soon convinced that the cause of this symptom, and of another strongly characteristic of this form of the disease, namely, the filling of the vessels of the sclerotica with red blood, was a congestive sub-inflammatory state of the brain

and spinal cord. This striking symptom first began to show itself in the inferior part of the globe of the eyes; it gradually increased, and little by little reached the upper part, while the eyes turned upwards exposed the lower part gorged with blood*. This state of the patient generally ended in complete coma, and proved fatal a few hours afterwards†." These various states also bear the closest resemblance to the different forms of "the stage of inflammation," occurring, at least in Europeans, in India. I am therefore inclined to conclude, that it is chiefly in the much greater frequency of the occurrence of this stage, and not in any essential alteration of symptoms, that the epidemic cholera of Europe differs from that of India.

This ordinary *protraction* of the disease has however produced remarkable changes in its general character. It no longer can be said of it, in the powerful language of Armstrong:—

* * * * * "And here the Fates
Were kind, that long they lingered not in pain;
For who survived the sun's diurnal race
Rose, from the dreary gates of hell redeemed."

It brings it nearer in character to the other great epidemics that have ravaged the world; and it is almost evident that it must alter or modify its general laws. Thus from the long continuance of a febrile state, strongly resembling those which in other diseases we know to be highly productive of contagious emanations, it is probable that an immense increase in the quantity of concocted poison will result, and perhaps also of its virulence. Hence may have arisen in a great measure that increase of its contagious power, which appears to have taken place, from the many statements that are made (in opposition to Indian experience) of physicians and other persons

* The "red-eye sickness" of the Travancoreans. The Russians have invented one of the most expressive of the numerous popular synonyms which the cholera has gathered in its course—the *Black Illness*.

† Papers of the Board of Health, p. 21—32.

about the sick, suffering in an excessive degree from the disease*; and also in part that surprising power which it seems to have acquired *since it entered Russia* of resisting cold.

We have seen that before and up to the period of the disease reaching Astrakan, it had been constantly arrested even by the tropical winters, and other moderate degrees of cold, which only it had then encountered. But after that period, though it still made its fresh appearances always in summer or autumn, and ceased each winter, it was found capable of existing under degrees of cold, which we have scarcely ever heard of any other pestilential disorder, much less cholera, meeting without immediate extinction. Thus it appeared in the province of Orenburg in August 1829, and had, in general, finished its course in November; but in a few instances it was found to prevail with unabated violence, and even to be propagated to other places, up to February, when the temperature was far below zero of Fahrenheit! In like manner, after having in the course of the following autumn, extended across the immense Russian empire, from the Caspian nearly to the shores of the Baltic, although its progress was evidently arrested by the cold, it was not extinguished in many places until the depth of winter, if indeed it did not in some districts entirely survive it.

But let us call to mind the extreme difference of mode of life in these countries and in India. In the latter the living *sub dio*—the free ventilation—the cleanliness, enforced in the case of European soldiers, and carried by the Hindoo, both from religion and choice, to a most scrupulous extent, form a complete contrast to the habits, described by travellers, of the

* The supreme Medical Board of Russia make the following statement:—"From all observations collected we must come to the conclusion, that the contagiousness of the cholera, though in some instances incontestible, is nevertheless not so apparent as that of the plague and yellow fever. The infectious power is not so visible in its operation on all who come in collision with those affected with it. *This is most conspicuous in the primary stage of the disorder.*"

lower orders of Russia, Poland, &c., of living in close apartments heated by stoves (where wood is plentiful), and sleeping, in a state of great filth and wrapt in warm furs, numbers in the same room. It is, therefore, somewhat less surprising that this tropical exotic should have been kept alive in these hot-beds of contagion, even into the very midst of a Russian winter. And the wonder may perhaps be entirely explained by the supposition of a greater virulence of the contagion, arising from the protracted form of the disease. Whether that extraordinary protraction and malignancy have arisen from those habits, or from difference of climate, or other circumstances, is a most important question; but in the present state of our knowledge of the subject, it appears unanswerable.

We have seen with what rapidity and fatality the epidemic traversed Russia in 1830. There is one remarkable fact, which affords a strong presumption that it must have been highly favoured in that course by atmospheric influence. It made its first appearance at Astrakan in September 1823, but it then destroyed only one hundred and forty-four persons, spread no further, and was soon totally extinguished, for it was no more heard of in that quarter for six years. And at Tripoli in Syria, at or about the point of its furthest extension westward, which it reached in the same autumn, its mitigation was still more evident, for it carried off only thirty-one, out of a population of 15,000. How different was the case on its second visit to Astrakan, in 1830! The brig which enjoys the Ephesian fame of importing the present epidemic into Europe, entered the mouth of the Wolga on the 20th of July, having lost eight men of cholera on her short passage from Baku. The disease did not then exist in the city or its neighbourhood, but on the 27th of August it had destroyed 4,043 persons in the city, and 21,268 in the province of Astrakan, and penetrated eight hundred miles into the interior of Russia *. It is perfectly evident, that some great difference of circumstances must have existed to produce this

* Moreau de Jonnès, Rapport, p. 290.

marked difference in the activity and virulence of the disease; but the time of the year was about the same as on the former occasion, the locality, the habits, and constitutions of the people were the same; to what cause then can it possibly be attributed, but difference of atmospherical condition, whether or not it was evident to observation? The conclusion of this unparalleled epidemical invasion is equally indicative of external influence. After traversing the continent like a meteor, it is suddenly arrested on the approach of winter about the same time at the distant points of Vologda and Pskov, and reaches not Riga, only one hundred and eighty miles—one week's march—farther in the latter direction, until eight months have elapsed. After the mass of evidence of this kind that has been brought forward, it would be perfectly nugatory to say, because the disease sometimes exists to a partial extent under the most unfavourable conditions of both the heat and electricity of the atmosphere, that it is uninfluenced by such agencies; or because it is dependent on contagion, that it is independent of other causes.

I have met with few notices of the meteorological states attending the spread of the epidemic in its course from the shores of the Persian gulf to the centre of Europe. Whether they have been ordinary or extraordinary, they appear to have been little noticed, as far as my limited means of research have extended. But some few, straggling facts there are, which convince me that the epidemic cholera on which the eyes of all Europe are fixed, is still the cholera of my experience, in all its relations. For example: When it first appeared at Orenburg, in 1829, at the hottest time of the year, and in the southernmost part of Russia, it is incidentally mentioned, that the weather was raw and wet. At the same time of the following year, the inhabitants of Nishni-Novogorod are warned by the authorities to avoid exposure to "the bad weather prevalent at that time of the year." M. Joenichen states, that the prevalence of the disease at Moscow was in proportion to the humidity of the at-

mosphere. Dr. Barry reports, that the weather was very hot at Petersburg (thermometer steadily above 70°), when it prevailed there. And Dr. Gibbs states, that frequent gales from the north-east and east-south-east had occurred during the time, " the trees were much blighted, and it is remarkable that since that period almost all persons have complained of a tendency to diarrhœa, in some cases profuse." M. Londe reports, from Warsaw to the Academy of Medicine of Paris, that the disease, which had apparently disappeared there, had recommenced its ravages in July last, which he attributes to the lowering of the atmospheric temperature, and the prevalence of almost continual rain. And Dr. Foy states, that " the disease had always been observed to appear, and when already present to become aggravated, after four consecutive days of a north wind, and after any sudden diminution of temperature." The Medical Board of Riga states, that the cholera appeared there at the commencement of uncommonly hot and sultry weather. At Dantzic also it is stated, that after it had considerably abated, it began to increase simultaneously with the setting in of close, damp, hot weather*. A great storm

* The following extract from the public prints of August seems to prove that this summer is an extraordinary one in the south of Europe.

" Extreme Heat.—A correspondent writes from Verona, that the oldest person does not remember so hot a summer as the present. In Middle and Lower Italy, the almost insupportable heat produces brain fevers and other disorders. At Rome, the heat rose to 30° of Reaumur. In that city eighty-six persons have within a short period been sent to the lunatic hospital. Letters from Tyrol say, 'The heat here is almost intolerable. The harvest is over, and at Botzen the grapes are completely ripe, a circumstance which has not occurred for half a century.' " Statements are also made of violent storms in Switzerland and France in August, and an earthquake at Besançon on the 17th; and Webster would have had no doubt that the new volcanic production of Graham's Island was connected with the cholera. In the Quarterly Journal (June 1829) it is stated, that furious tempests had raged through the south of Europe from the 19th to the 23d of February 1828, accompanied by an extraordinary depression of the baro-

and inundation are recorded at Petersburg and Cronstadt in the beginning of September. Vienna exhibits one of those every-day instances in India, of the epidemic being ushered in by a storm — probably the same as that just mentioned.

meter, particularly on the 21st, when an earthquake occurred in France and the Netherlands. "A new example," it is added, "of the coincidence of these phenomena." And in volumes vi and vii of the Edinburgh Philosophical Journal, are accounts of a storm which prevailed all over Europe on the 25th of December, 1821 (the day after the moon's change), accompanied by great depression of barometer, *agitation of the magnetic needle*, igneous meteors, inundations, &c., and an earthquake at Mayence on the same day. Four days before an extinct volcano in Iceland began to show symptoms of eruption; on the 25th it burst forth with excessive violence, accompanied by the same atmospherical phenomena as occurred in Europe, on that and the two following days. A volcano burst forth near Booj in India shortly after the great earthquake of the 16th of June 1819, and whilst minor shocks were of frequent occurrence there.

The connection of earthquakes and atmospherical disturbances and irregularities of seasons with epidemics can scarcely be disputed, and if the eruption of volcanoes, particularly of new or extinct ones, forms a part of the concatenation, it lends a degree of probability to the hypothesis of changes in the interior of the earth being the original cause of all. These obscure and important operations have been attributed to the approach of comets. It is inconceivable that these bodies could influence the earth when at immense distances, but during the highly electrical state which they exhibit on their approach to the sun, arising from the vast chemical processes going on in them, it is not only possible but in the highest degree probable that they produce sensible effects on our planet. From the known law of electricity acting, like gravity, on bodies in inverse proportion to distance, it appears certain that some effect must result under the circumstances; and when we see the streams of electric fluid which form the tails of these bodies sometimes extending to greater distances than those which separate them from the earth, we cannot doubt that such effect might be most sensible. Was not then the Indian earthquake of the 16th of June 1819, a discharge of electricity produced by the great comet which was then within ten days of its perihelion? The autumn of 1811 was not more remarkable for its comet than the numerous earthquakes in North and South America, India, England, &c.

The Gazette de France states, that "the cholera broke out at Vienna on the 13th of September, after *a hurricane* and much cold rain; having long been checked in its progress by strict sanatory measures." This long interruption to its progress was probably owing to causes of infinitely greater efficacy than quarantine, or any other human means. The disease had long been within a short distance of Vienna, and it is probable that the contagion had been imported into the city some time before the distinct eruption, for straggling cases had been occurring from the 31st of August, but it appears that it was unable to burst into open combustion until it gained that atmospheric pabulum which has so generally, at least, appeared necessary to its existence. *About the same time a violent earthquake was felt* at Parma and Venice, and various other parts of Italy. On the 21st of September the weather at Vienna was observed to become fine, and on that day the epidemic began to abate. There is no other nor stronger evidence of ague arising from marsh miasmata, or typhus from human effluvia, or hydrophobia from the bite of a mad-dog, than that which exists of cholera arising from conditions of the atmosphere indicating the presence of negative electricity.

There is also considerable evidence of the existence of a general morbific state of the atmosphere attending the disease, from the simultaneous prevalence of other epidemics, both in the same and in other countries of Europe. Mr. Searle observes, that "in situations ordinarily healthy fever has not unfrequently succeeded to, or been conjointly prevalent with cholera during its epidemic visitation, and such is the case at the time I am now writing, here at Warsaw; cholera and fever of a remittent type being both extremely prevalent, and the milder attacks of the former lapsing in most cases into the latter." M. Labal also:—"Modified by difference of climate and change of seasons, the cholera loses much of its violence in winter, and increases in summer. It may also exist in conjunction with other epidemic diseases, and occa-

sionally render them so complicated that the real character of the affection cannot be discovered, as has occurred at Warsaw, where the cholera commits less ravages than the typhus in our army." In like manner it is stated at Pesth:— "The cholera is gradually abating here, but other malignant disorders, especially nervous fevers, carry off many persons. Private accounts also say that a malignant typhus prevails in the county of Nesgrod." And recent accounts from Syria (it is stated) "contain most frightful accounts of the progress of the plague and cholera: that in Bagdad 12,000 houses are empty, and that the Tigris had twice overflowed its banks and done great mischief," and that three-fourths of the pilgrims at Mecca had been destroyed by the cholera. Many other accounts are also scattered through the public journals of prevalence of plague in various parts of the Ottoman empire both in the last and present summers. At Elsineur, at Paris, and other places, the morbific state of the atmosphere has likewise been shown by the existence of various anomalous epidemics.

The extraordinary prevalence of sporadic cholera all over England during the present autumn has excited general observation, surely much greater than can be accounted for by particular attention having been excited to the disease; and during July and August the atmosphere has commonly exhibited great appearance of disturbance in the equilibrium of its electricity.

Dr. Burne, in his valuable "Dispensary Reports," published in the London Medical Gazette, observes (July 2): "During the raging of the cholera on the continent last year there occurred at the dispensary a great number of cases of dysenteric diarrhœa and cholera; which had so decidedly an epidemic character, that I believed them to be produced by the same causes which were in operation on the continent." And again (July 16), "The simultaneous existence of the dysenteric diarrhœa and cholera in this metropolis during the last fifteen months, and of the cholera in Russia,

in latitudes where it has not before been known to prevail epidemically, is a striking coincidence which invites to reflection, and suggests the inquiry as to whether the notion of atmospheric influence is supported by sufficient facts. Certain it is that infection has not hitherto been in operation here, and equally certain does it appear to me, that the seasons, during the past eighteen months, have been characterized by epidemic peculiarities. The atmosphere has, on the whole, been loaded with humidity, and the extreme of heat and cold have not been such as to admit of continued hard frost, or continued dry hot weather, but of that medium degree which, with humidity, is unfavourable to animal life. * * * * Other disorders too have assumed a marked adynamic character, as the scarlet fever, the eruption of which has often been ill developed, and the attack so violent, as almost to extinguish the vital functions at once, or so to depress them, that the patients have sunk, sooner or later, without reaction. I have lately witnessed the scarlet fever attack by a violent vomiting and purging, which have sunk the powers of life and lowered the temperature of the body to a degree that has never been recovered. These data lead me to the conclusion, that the present season generates a predisposition to epidemic disease, which would not only favour the introduction of the cholera by infected persons, and the propagation of it when introduced, but would even go far to generate the disease." I have also the authority, vivâ voce, of Dr. Clanny, for the most unusual prevalence and malignacy of cholera at Sunderland during the present autumn. — It is greatly to be feared that these are but the skirts of the approaching shower. This unusual prevalence of common cholera remarkably accords with the same fact, as already stated, occurring on the peninsula of India the year before the epidemic reached it, and when Bengal was actually suffering its ravages.

The influenza, though so different in its nature, exhibits strong and singular analogies with the epidemic cholera in its habitudes; — its wide range through countries and climates

the most dissimilar — its sudden attack, and the short periods in which it pervades a body of people, and finishes its course among them — and the rapid and progressive, but often singularly desultory manner in which it traverses vast portions of the globe, in consequence, as it would appear from very strong evidence, of contagion *. It is probable, therefore, that they are propagated by effluvia in many respects similar, but happily there is a wide difference in the degrees of susceptibility which they find in our frames, or require to take effect; for if we were equally vulnerable to the virus of cholera as to that of influenza, it would almost depopulate the earth! The influenza of 1782 is traced from China by Tobolsk to Moscow, where it arrives in December 1781. It reaches Petersburg in February and Denmark in April, London in May, Newcastle in June, and in that and the following month diffuses itself over Scotland and Ireland. In these two months too, it traverses France, in July and August Italy, and in August and September Spain and Portugal; and in the following year extends over the United States

* Let the derider of contagion, or the sceptic who would limit its influence to the most obvious cases, follow a pack of hounds, and observe the inconceivably minute portions of animal effluvia remaining on the track of a hare, after exposure for hours to wind, sun, and even rain, still tainting the atmosphere sufficiently to be evident to their fine sense; — the emanations being strongest, and reaching to the greatest distance, cæteris paribus, in a calm and warm atmosphere, and ceasing entirely to be conveyed when the temperature approaches the freezing point. These effluvia must also be infinitely various, since a dog is able to distinguish the footsteps of his master from those of others by the scent. There is therefore no want of evidence of the possibility of the different contagions existing in, and being conveyed by fomites, even under very adverse and improbable circumstances, and being diffused from them (and, a fortiori, from their source) to unknown distances through the atmosphere. These subtile and potent essences will probably never be immediately exposed to our senses, in any separate or tangible form, but the different laws to which they are subjected will surely be sometime elucidated; and, "veniet tempus quo posteri nostri tam aperta nos nescisse mirentur."

of America. It is evident that its general course has been more rapid than that of the cholera, but not more rapid than its progress through Russia in 1830.

Webster shows, that the great plagues have all been preceded or attended, in the same or neighbouring countries, by minor epidemics. He says: "Catarrh appears to be the disease most connected with pestilence. * * * As it precedes, so it follows every severe epidemic pestilence*." And the late general prevalence of that disease in Paris, in London, and various parts of England, ominously corroborates these observations. Dr. Burne states (July 2): "A disorder, according exactly with the *tussis epidemica* of Sydenham, and the influenza of later authors, has prevailed epidemically for the last two weeks in this metropolis, affecting all ages, and supervening without any assignable cause." The latter circumstance is very characteristic of the epidemic, and together with the greater violence and frequency of the disease, is quite sufficient to distinguish it from the common catarrh. Mr. Bennet, in a very interesting paper on influenza, published in the same journal (July 23), states that he had observed it prevailing extensively in Plymouth and its neighbourhood in that and the preceding month. He also gives an account of the prevalence of the same epidemic which he had witnessed at Manilla in September, 1830, and its accompanying atmospheric phenomena. The disease prevailed also about the same time in China. "The last epidemic that occurred at Manilla, similar in character to the present, was in 1810. The season (1830) in which I made these observations, was marked by uncommon dryness, and unusual atmospheric changes. The rain that fell was in small quantity, and chiefly as passing showers. * * * * * Previous to the appearance of the epidemic, the weather had been unusually hot and dry for the season of the year, which, combined with a very variable atmosphere during the day and night, was considered by

* History of Epidemic Diseases, vol. ii, p. 35, 39.

the inhabitants so unusual, *that the occurrence of a severe hurricane or an earthquake was predicted.* The time during which this epidemic occurred was what is termed the rainy monsoon, but which, as has been before observed, was attended by very dry weather. Persons were seized suddenly while at work, and when remote from contagious causes. Some had retired to rest perfectly well, and were *attacked during the night.* The disease must be therefore assigned to the true exciting cause—the variable state of the atmosphere which existed at Manilla during and previous to the epidemic, and which same variableness has also been remarked in this country." Mr. Bennet also adduces evidence of atmospheric influence producing the influenza in New South Wales, and alludes to the common observation of particular idiosyncrasies being always affected by particular winds*, and adds, that " others again suffer violent headaches

* Read observes in his Treatise on Atmospherical Electricity: " In an easterly wind of long continuance, and which was reckoned unhealthful, the electricity was so faint as to require the nicest of all known tests for discovering its existence;" and for farther observations regarding this wind, see pages 164 and 417 of the present work, and the review of Macculloch on Malaria, in volume xxiv of the Quarterly Journal.

A very recent work by Dr. Allan, on Insanity, contains abundant evidence of the morbific influence of the changes in the electrical states of the atmosphere. He observes:—" I am quite certain that an excited and unsettled state of insane patients is prior to, and co-ordinate with great and sudden alterations in the atmosphere, and altogether co-ordinate with sudden and great alterations in its electrical state." Again: " During unsettled weather, thunder-storms, high winds, equinoctial gales, especially when attended with the sudden accession of warm, dry spring weather, or when a hot, dry summer is succeeded by a cold and wet autumn, an awakened and unsettled stir of the spirits of the insane is most marked and decided, and appears very like a new accession or exacerbation of their disease."

Dr. Allan finds an increase of the excitement of the insane taking place at certain periods twice in twenty-four hours, which may be exhibited as follows:—

when the atmosphere is charged with electric fluid, and which subsides when that peculiar state of weather is passed." The great *variability* of the atmosphere which he so particularly notices, must always have been attended with great changes in the state of its electricity, whether or not they were evi-

Increased excitement.	Diminished excitement.	Increased excitement.	Diminished excitement.
4 A. M. to 9 36	A. M. to 4 P. M. to 9 36	P. M. to 4 A. M.	

These observations agree very remarkably with those recorded at p. 246 of this work, of the diurnal variations of the electricity of the atmosphere. It would be highly important to ascertain if any variations in the proportionate quantity of carbonic acid exhaled from the lungs corresponded to the observed changes in those subjects?

Dr. Allan also quotes the following very strong evidence of Dr. Forster: "Epidemics, particularly the most widely extended and terrible kinds, have generally been preceded, as I have repeatedly shown, by the unusual prevalence of fiery meteors, by earthquakes, northern lights, and other electrical phenomena in the air, and by comets and unusual aspects of planets, and often eclipses. They more frequently set in with electrical changes of weather, about the periods of the new and full moon, than at other times, while at these lunar periods the disorders themselves of the individual patients, already produced by the air, usually have their crises. Epidemics too, more frequently occur with east winds than with any other, and often follow their course. They avoid the long-continued electric cold and dry air of the higher latitudes, in wholesome polar winters, and most abound where marsh and animal effluvia, moisture from waters and other causes, aid the communication of the electric fluid. Lastly, my own experiments with atmospherical electrometers tend directly to show that healthy times are those in which the air is highly and perhaps positively electrified, while unhealthy periods have been accompanied by a comparatively non-electric state of the air, or by an unusual disturbance in its electricity."

From whence arises the extraordinary exhilaration which every one has experienced from a frosty atmosphere, and its equally remarkable healthiness, but from the abundance of positive electricity, which we know to exist in it as certainly as that its temperature is below the freezing point?

dent to the unaided senses. It appears to me all but proved, that these changes are capable of producing in predisposed habits, of themselves, common catarrh and sporadic cholera, and in combination with contagion, influenza or epidemic cholera. Dr. Good states, that influenza has been attributed to "some intemperament or inharmonious combination of the elementary principles of the atmosphere, and particularly to its being *in a state of negative electricity.*"

Although there is little hope of our island escaping a visit, sooner or later, of the disease, I agree with Dr. Johnson in anticipating no great extent of mischief from its prevalence. The ravages of the sweating sickness in England may indeed afford a contrary argument; but there is every reason to believe that the general state of the atmosphere in Europe has undergone some great change since those days, which render it much less favourable to the prevalence of epidemics. And admitting that our climate appears at times sufficiently favourable to the cholera, all our other circumstances seem decidedly adverse to it. There are scarcely any parts of the island which can be termed unhealthy, and our capital is stated on strong grounds to be the healthiest in the world. Our lowest classes hold a higher place, both moral and physical, in the general scale of society, than those of any other country, and our humane and generous poor-laws render absolute want of the necessaries of life among them impossible. There is therefore reason to hope that we may escape with a mild visitation of the epidemic, excepting perhaps some of our large manufacturing towns, where scarcity, filth, close and crowded habitations, and their attendant typhus prevail to a considerable degree;—if indeed any thing can be foretold of a disease which has so often defeated the best-grounded anticipations. But far different is the prospect of Ireland. In that greatly over-populated country, typhus is always endemic or epidemic to a serious extent, and the principal part of its population is always at least on the verge of misery and

famine. The insufficient nourishment of the native of India (but rarely amounting to absolute want) has been found highly conducive to the disease, and therefore at least the same effect may be expected from the *greater* degree of the same cause which exists in our unfortunate sister-island, combined as it is with the usual concomitant of poverty, uncleanliness. A large portion of its surface is of that low, level, and swampy nature, which in other countries has been so particularly obnoxious to cholera; but there is reason to hope that it will not be more liable to it on that account, for from the happy circumstance of an antiseptic property which is found in the soil of those peat-bogs (by which both animal and vegetable substances are preserved entire for long periods of time) they are not productive of malaria.

APPENDIX.

COPIES OF REPORTS

Made by the Author to

THE MEDICAL BOARD OF MADRAS.

No. I.

Report on the prevailing Diseases in His Majesty's 34th Regiment, for the months of May, June, and July, 1820.

On the 25th of May the regiment marched from Bangalore for Madras. As it has been observed of late that corps, in marching from station to station, have been particularly subject to attacks of the epidemic cholera, apprehensions were entertained that the 34th would suffer from it on this occasion, but, with the exception of a few straggling cases, the corps entirely escaped during its route. Several of these cases made their appearance in the early part of the march, whilst they were still in the Mysore; the weather being cool, and very unsettled, frequently cloudy, rainy, and squally. Besides the well-marked cases, which have been returned under the head of Cholera, a considerable number of others occurred which bore much resemblance to the disease, and appeared to me to consist of its slightest degrees. This tendency was evident in the corps on the 6th of June; but on descending the Ghauts on the following day, and entering the plain of the Carnatic, it appeared to cease; at the same time a considerable increase of temperature was experienced; the air was found to be dry, and the weather serene. This state of things continued until the 11th, the day of new moon, when the regiment arrived at Arcot; on that day, one marked case, and on the 14th two others appeared, clearly in connection with squalls and rain, which simultaneously took place. The 14th was a rainy and hazy day, and the quantity of rain which fell

was very considerable; after this the weather became almost uninterruptedly fine.

On the 18th, the corps arrived at St. Thomas's Mount, where they remained a fortnight encamped. Here no case of cholera was observed until the 26th, when, *within a few hours of the full moon, and during a squall, with heavy rain,* the fatal case made its appearance. About the same time, likewise, several cases occurred among the camp-followers; and I am informed that three cases were observed on that day in officers' servants, at the Mount. The fatal case, by the man's own account, had begun with diarrhœa several days before, but it is clear that it assumed the form of cholera during the state of the sky above-mentioned. It was chiefly marked by the rapid sinking of all the powers of life, and towards the conclusion by coma, and heavy respiration. The usual burning pain at the stomach was not present, and there was very little thirst: on dissection, the cause of this anomaly appeared to be evident in the stomach exhibiting scarcely any of the usual appearances of inflammation. It is very remarkable that an abscess, containing about ℥ij of very thick, white pus, was found in his liver. There was no reason to suspect this before death, as he had not been seen at the hospital since he was discharged, about a month before, after recovering from a common dysenteric attack. It is very probable that this state of the liver was the origin of the diarrhœa (or perhaps dysentery) which immediately preceded the attack, and the predisposing cause of the disease which put an end to his life.

After the arrival of the regiment at Madras, and their being put into barracks, a few cases of cholera continued to occur from time to time; very evidently connected with evening thunder-storms and squalls, with occasionally heavy falls of rain. No less than two of these terminated fatally. The first of them, after running a very severe course, with the ordinary symptoms, came to a favourable crisis, the fulness of the pulse, general warmth, &c. returning, but he again unaccountably sunk into a low, dozing state, with a very weak pulse and great coldness, but scarcely any marks of active disease, and after lingering thus for thirty-six hours, expired. On dissection, nothing very satisfactory was discovered. The other case was far advanced previous to admission, and immediately afterwards the pulse suddenly disappeared, though he had not been bled, and death very shortly ensued.

There is every reason to suppose that a great number of other slighter cases of the disease have occurred in the corps during the periods abovementioned; for we know that soldiers will not report their illnesses until they assume a serious form; and I am convinced that the evacuations which this disease itself produces are in many instances sufficient for its cure.

During the stay of the regiment at the Mount, the admissions of dysentery began to increase, and after their arrival at the Presidency they became extremely numerous; the sick-list, on our arrival at the Mount,

did not exceed forty, and, in less than a month afterwards, it amounted to upwards of one hundred and forty. The greatest number of these consisted of dysentery, but of a very tractable form; for of ninety-seven cases, which have been admitted during the month of July, not one has terminated fatally up to this date (5th of August), nor as yet assumed a decidedly unfavourable tendency. Many of these cases were unattended with fever, and such were all mild and trifling. But in many others, the hot, dry skin, quick pulse, evacuations of small quantities of bloody mucus or serum, with constant tenesmus, pain both spasmodic and continual, and increased on pressure, and other threatening symptoms of dysentery, were present during the first days after admission. In one, gangrene took place, and a tubular slough, eighteen inches in length, of the inner coats of the intestine, was thrown off; at the same time, the mouth getting sore, the man rapidly recovered. In fatal cases of this disease I have always found gangrene taking place, generally many days before death, and the time of its occurrence was marked by a peculiar fetor of the evacuations, after which recovery was rare.

Bleeding, and particularly the application of leeches over the abdomen, were liberally employed. The last of these points of practice cannot be too strongly recommended in the inflammatory diseases of India. The Indian leeches are very large, and easily procurable; any quantity of blood may therefore be quickly withdrawn in this way; and I have long been convinced that the benefit arising from the application of leeches is not confined to the abstraction of blood; for the great inflammation, tumefaction, and soreness which attend their bites, must be productive of much counter-irritation; and as the wounds extend through the true skin, they must affect its sympathies and those of the cellular substance, like the seton or the actual cautery. It appears to be chiefly in this way that leeches act almost like a charm in the dispersion of buboes.

In a great number of the dysenteric cases, bleeding, a few doses of calomel and castor-oil, and removing the men from their usual sottish way of living, were found sufficient for the cure, without affecting the mouth with mercury, a measure which was always avoided where it appeared unnecessary. In others the calomel was persevered in, in divided doses to the extent of ten or fifteen grains per day, until ptyalism ensued. In a few of the most severe cases, scruple doses of that medicine were given once a day, on every second day, alternately with the small doses, and I had reason to form a very favourable opinion of that practice. In no instance did it appear to increase the excitation of the bowels. Tartrite of antimony was usually given in combination with the small doses of calomel. In all the severer cases large blisters were applied over the abdomen, and were found immediately to relieve the pain.

Thirty-four cases of simple continued fever were also admitted dur-

ing the month of July; exhibiting frequently much increased arterial action, and entirely unattended by any tendency to the typhoid type. They all yielded readily to bleeding, purgatives, and low diet.

It is not improbable that the increase of temperature which the corps has experienced in removing from the Mysore to the Carnatic, has had a considerable share in production of the above-mentioned increase of disease; but it has been generally observed that the last two or three months have been unusually cool at Madras for the time of the year. The principal cause appears to be the very unusual weather which has prevailed during these months. They are generally very dry and clear, and attended by hot land winds; but during this and the two preceding years, they have exhibited very different states of the atmosphere. The editor of the Government Gazette observes, on the 20th of July, "The weather at the Presidency lately may be considered as far from seasonable; the winds from the land have been comparatively cool, and instead of the usual breezes, the March, or along-shore (southerly) wind has generally prevailed. There have also been frequent showers, with thunder and lightning. On Tuesday night, the lightning was extremely vivid and near, &c." This kind of weather has since continued; being usually cloudy, with daily squalls, and often heavy rain. The atmosphere has appeared very moist. The refreshing sea-breeze very seldom appears, but whenever a serene day occurs, it springs up.

This state of the weather strongly resembles those which, in a vast number of instances, I have found to attend the prevalence of cholera. The cases of that disease which have occurred in the corps of late, appear to me clearly to be owing to the deficiency, or the want of equilibrium in the aerial electricity, which observations have shown to attend this kind of weather; and it is extremely probable that the dysenteries and fevers which have prevailed at the same time arose from the same cause, varied, perhaps, in degree. In one instance this supposition appeared to me evidently to be true. A man who came to hospital with a smart attack of fever, informed me that he was standing sentry, and felt perfectly well just before it came on; that a flash of lightning came, which left behind it a strong smell of sulphur (an usual attendant on electrical discharges), and immediately he felt very giddy and deaf, and so weak that he was obliged to ground his arms. From this time he felt a violent headach with fever. The case was one of pure synocha, and required large depletions to effect its cure. The man appeared struck by the manner in which his illness came on, and gave the above account without being led to it by inquiry*.

* A similar instance of disease being observed immediately to arise from meteoric influence, is related in the account of the "endemial causus" of Ellore (mentioned at p. 127), which is given in the Madras Report on cholera, from its evident alliance with that disease. "The only instance which fell under my observation, where the winds appeared to have any influence, was during a storm,

No. II.

Report dated Sytar, Southern Division, September 15, 1820.

I am sorry to state that the epidemic cholera has appeared in a violent form in the detachment under my charge; three cases having occurred yesterday, in an officer (Lieutenant N.), a private, and a horsekeeper, which all terminated fatally in the course of the day and last night.

During the first fortnight of the march of the party (from 1st to 14th August) the weather was unsettled and showery, and in this period three cases of cholera, and numerous cases of a severe form of dysentery, were met with. On the 14th of August a heavy fall of rain took place, after which the weather cleared up, and, with the exception of one day, continued perfectly serene, without a drop of rain, until the 13th inst. All this time too, the detachment continued healthy, no case in the least resembling cholera, and very few of any other disease, appearing. About the 10th inst. the wind was observed to have got round steadily to the east and north-east (the monsoon quarter), and on the 13th great quantities of heavy clouds made their appearance, and were seen discharging their contents in numerous and very partial showers all around us. Several of these visited our camp, attended by squalls of wind, but the quantity of rain which fell was very inconsiderable. It was during the night of this day and the following morning that two of the cases originated. On the 14th the weather was very similar, little rain falling with us, but we discovered next day that a very heavy fall had occurred at this place, within ten miles of us. On both days the air was very sultry and oppressive, the thermometer rising to 97°.

which lasted from sunset till about nine o'clock on the night of the 23d of May. The sky had been overcast from five of the afternoon, and it began to blow pretty hard about sunset, the wind varying about suddenly from one point to another, at one moment cool as if rain was approaching, and at another hot as if from a furnace. And during these blasts, two men who were lying amongst many others in the open air, were suddenly seized with the disease whilst asleep in a very violent degree." The disorder is attributed chiefly to excessive heat, the thermometer standing in the afternoon at 102—106 degrees, whilst the disease prevailed, and the sky being generally without a cloud, but various heavy falls of rain are mentioned. It is particularly observed, that in the very sultry evenings an extraordinary *oppression of the respiration* was felt by all, and at that time the attacks most commonly occurred. It appears further that the same complaint was prevalent there in the same months of other years. The district is one of the northern Circars, which have already been noticed as particularly obnoxious to cholera.

All the three cases were chiefly marked by the rapid, indeed almost instantaneous sinking of the vital powers, and consequently their short duration, for they all terminated fatally in less than twelve hours from the attack. In only one of them were spasms experienced, and that but once and slightly. None of them vomited more than two or three times, or purged much; in short, they all appeared to be of the most perfect description of the low form of the disease, in which there is scarcely any increased action of any kind. One of these was in a private, convalescent from a very violent attack of dysentery. The officer was a rather delicate and somewhat unhealthy young man.

Bleeding was practicable in only one of the cases (that of the officer). In this instance, fourteen ounces was drawn in a small stream; whilst I was tying up the arm, a fit of vomiting came on, and the pulse, which was small and wiry before, entirely disappeared. In this case the principal thing complained of was an extraordinary sensation of heat all over the frame, although it was considerably below the natural temperature. The other usual remedies were tried in all; but cases of this kind appear to be entirely beyond the reach of all the means of cure yet put in practice. It is however to be hoped that the knowledge of the cause will direct us to something more equal to the cure of this horrible disease.

The foregoing observations on the states of the atmosphere accompanying the appearance of the epidemic, perfectly coincide with those recorded in my work on the subject, and with many others which I have since made; so that I cannot entertain a doubt that the cause exists in some condition of the air, whose presence is thus indicated, and it is very certain that changes in the electricity of the atmosphere accompany the phenomena which are thus constantly found to attend the disease.

Additional Observations, 1831.

I have no notes of the farther prevalence of the disease or its accompanying atmospheric states on this occasion, but remember that it shortly ceased, no further deaths ensuing, and that the party prosecuted the rest of the march to Cape Comorin, and even across the dangerous boundary of Travancore, in health.

I was never so much struck with the approach of death, nor had so distinct an opportunity of observing the origin of the disease, as in the case of the fine young man, the officer above mentioned, as I was with him, not only during all the early part of the case, but for several hours before its commencement. It was on a halting day; I was out hunting with him before breakfast, as is usual in India; he was then quite free from indisposition, and in high spirits, and probably neither

of us ever spent a much more agreeable morning! I well remember his being thrown into excessive paroxysms of laughter by the grotesque and indecent figures carved on the *rhut*, or huge pyramidal procession car in the village. The exercise we took was very moderate. After breakfast he began to complain of slight spasmodic pain in the intestines, for which he took a little brandy; in a very short time the disease was fully developed, and in four hours more the case was hopeless. It appears then that the system was in the state of health, even *above par*, up to a definite time, when a change took place, as if he had taken a considerable quantity of prussic acid in his tea. Effects cannot arise without causes — what was the *immediate* cause of that fatal change? There was no corresponding change in the atmosphere at the moment, nor in any other external circumstance which appeared in the smallest degree capable of producing injurious effects. We are therefore constrained to look for some internal operation, which made the disease arise at that particular moment; and it appears to me in the highest degree probable, that that circumstance was one of those common fluctuations or *oscillations* in the chemical process going on in the lungs, for the knowledge of which we are indebted to the zealous researches and penetrating observation of Dr. Prout. Such variations taking place in healthy states of the atmosphere — in the absence of contagion — and with the ordinary compensating powers of the system, may be harmless; but under other circumstances the immediate origin of disease. It is very certain that in cholera the arterialization of the blood is interrupted; for that inference has been confirmed by the experiments of Dr. Davy, which prove a greatly diminished evolution of carbonic acid from the lungs during the disease.

Dr. Prout finds that the depressing passions immediately diminish the quantity of carbonic acid emitted at each expiration, and is it not thus that they operate in exciting cholera? In common circumstances we constantly find these agents producing in the digestive organs symptoms similar or analogous to those of cholera, the least of which are anorexia and indigestion; for example, I know one person, ordinarily of a costive habit, who is constantly affected with spasm of the intestines and diarrhœa on suffering terror, grief, or anxiety; and another who on similar occasions is affected with the spasms, but generally without the diarrhœa, and often with great oppression of the respiration, when the cause is sudden. It is most probable that were contagion present, such cases would run on to epidemic cholera. And we see that similar affections may be more directly produced, in the absence of contagion, by the influence of an atmosphere unequally charged with electricity; as in the case related at p. 377. I have very often seen one of the persons above mentioned suffer from *dyspnœa* and disorder of the digestive organs during such states of the weather, or from the malaria of a

damp church or a crowded room*. And do we not continually find such causes in India developing the germ of the contagion of cholera? Dr. Edwards infers from his valuable experiments, that "the lungs possess a greater capacity for decomposing the air in winter than in summer; an effect which appeared to be brought about by the long-continued action of a low temperature upon the constitution†." And is not this the explanation of the manner in which continued heat so eminently predisposes the frame to cholera‡? Dr. Prout and Dr. Fyfe likewise find that fatigue, alcohol, and the full influence of mercury on the system, all remarkably diminish the proportionate quantity of carbonic acid emitted from the lungs, and these are all evident causes of cholera. Dr. Prout also finds that strong tea immediately produces the same change in that function on which our life immediately depends: it is possible therefore that the portion of that beverage which Mr. N. took immediately before the attack, may have been the last drop which filled to overflowing the cup of his fate.

These are not idle speculations, for if confirmed—and their probability cannot be denied—they will surely point to some effectual means of cure; not through the dark and dangerous paths of empiricism, but by the broad light of the knowledge of causes. The theory of the causation of cholera which has been proposed is doubtless very imperfect, and it may be, in part erroneous. There are hiatus to fill up, and even contradictions, real or apparent, to reconcile, but its leading facts are clear and accordant and tangible; and I doubt not the investigation it must receive will quickly show at least—if it is not already evident—that we are on the right path. Dr. Philip infers:—"When the lungs are deprived of the nervous influence, by which their function is impeded and even destroyed, when digestion is interrupted, by withdrawing this influence from the stomach, these two vital functions are renewed by exposing them to the influence of a galvanic trough." Is it possible to charge a portion of air with the galvanic fluid, and thus convey it into the lungs?

* See Philosophical Transactions for 1794, p. 226, and Read on Atmospherical Electricity, for the "NEGATIVE ELECTRICITY OF VITIATED AIR."

† Bostock's Physiology, vol. ii, p. 93.

‡ M. Moreau de Jonnès, although he seems very averse to admit the agency of any cause but contagion in producing the disease, fully recognizes the influence of temperature. The following is one of his "resultats generaux." "5. Une temperature élévée est l'une des lois auxquelles est soumise l'existence du choléra pestilentiel, puisque cette maladie est originaire de la zône torride, et qu'elle ne s'étend que pendant la saison la plus chaude dans les contrées de la zône tempérée. Le froid de l'hiver la fait cesser entierement ou l'endort; mais l'exemple recent de sa prolongation, en Russie, malgré les frimats, prouve que son germe peut conserver son activité, par l'effet de la temperature artificielle que produisent les pôeles et les fourrures."

No. III.

Report, dated Wallajabad, 22d June, 1822.

I do myself the honour to forward to the Medical Board a few observations on the severe epidemical attack of cholera which has lately been experienced by H. M. 34th regiment.

The cases which appeared on that occasion did not in general exhibit any marked difference from those which were observed during the first prevalence of the disease in 1818 and 1819. I was, however, struck with the absence, in many cases, of some of the most remarkable symptoms. The burning and pain at the stomach were but seldom observed. Spasms were often entirely absent. Vomiting was little remarkable, and soon ceased, particularly in the most severe cases. Watery purging I have always found the most constant symptom, and generally the first that is taken notice of. It usually comes on very suddenly, and the stools recur at very short intervals, and are accompanied with great sense of debility, with paleness and shrinking of the features. These symptoms are, alone, I conceive, sufficient to point out the presence of the disease, and the necessity for the immediate employment of its remedies. On the last day of the disease prevailing with any severity in the corps, two cases occurred, which are fresh instances of the great variety of forms which it puts on. In one of them, there were most violent and painful spasms, but no other symptom of cholera excepting thirst, and once retching. It was speedily cured by bleeding, opium, and brandy, and as usual ended in sound sleep. In the other, there was no perceptible appearance except the spasms. The patient looked and felt well except being tormented with cramps in his limbs, which lasted about twenty-four hours.

It has been commonly observed, that our chance of success in the treatment of the disease depends much upon the progress which it has made when we are first called in; but probably few, at least of the actual sufferers, are sufficiently impressed with the vital importance of attention to this point. The severe kind of the disease seems, in general, to have a tendency to run on progressively to death, unless interrupted by art; but if taken in time, it is probably more under the control of medicine than any other dangerous disorder. Almost all the fatal cases in the late attack in the 34th regiment were very considerably advanced before they came to hospital; and the deaths of a number of them may be fairly ascribed to that circumstance. Soldiers are usually so careless and stupid, that it is very difficult to get them to

hospital when first attacked; and on that occasion it was particularly so, on account of the confusion and drinking in the corps owing to its volunteering.

The treatment we adopted was in general the same as had been previously employed—opium, spirituous and aromatic stimulants, blisters, occasionally bleeding, and, after the favourable crisis, calomel and purgatives. The aromatic which was generally employed was *cloves;* and it appeared to me extremely well adapted for the purpose. It is highly agreeable to the taste, and an active stimulant. It was usually given in the form of a tincture, composed of ℥iij of bruised cloves to a bottle of brandy. A draught composed of ℥ss. of this tincture, with ʒj. tinct. opii, and a little water, was usually given at first, and repeated as often as rejected, care being taken to ascertain that it was actually thrown up. If relief was not obtained in two or three hours, it was repeated, though not rejected. The following mixture was also in general use.

℞. Sp. vin. gallic ℥xvi.
Aquæ puræ ℥xxxii.
Tinct. Caryoph. ℥xii.
Acid nitric. ʒiii. M. ℥ii omni hora sumend.

Nitric acid is recommended in a paper which was circulated by the Medical Board, and evidence is there adduced of its good effects in the disease. In some instances it had also appeared to me decidedly beneficial. It is certainly extremely agreeable to the palate in the above mixture, and tends to allay the excessive thirst, and probably to quiet the stomach.

Our experience with regard to bleeding has been rather unfavourable to it in the more common and severe form of the disease, that is, where there is great debility of the circulation, coldness, and paleness of the surface. In several cases where it was tried, it was followed by irretrievable sinking. But in a numerous class of cases where there was considerable appearance of increased action, as flushing of the face, temperature rather above, or not below natural, and often severe spasms, though the pulse in some of them was small and contracted, bleeding was attended with the best effects.

For a long time before the disease appeared in the 34th regiment, the weather was extremely clear. The first cases happened on the evening of the 14th May; and on the following morning a remarkable change in the weather was observed to have taken place, for during that and the two or three following days the sun was scarcely ever seen. About the same time the land-wind set in with great force, and continued for several days throughout the twenty-four hours. As it appeared from former accounts that these winds had a beneficial effect

on the epidemic, I was in hopes that they would have stopped its progress, but it continued to increase apparently uninfluenced by them. We had only two or three slight showers of rain whilst the disease prevailed, but there was much appearance of rain to the westward; and I was informed that a heavy storm, with rain, happened at Arcot on the 15th. The storm in which the *William Mills* was lost in the Bay began on the 17th, and the newspapers contain many accounts of stormy weather in the Bay during the month. I am informed also that a violent squall with rain happened in the camp of the 53d regiment, when they were attacked with the cholera, about the time of their entering the Carnatic, and swept down their tents. The excessive heat at the Presidency during the latter half of the month, and the great number of sudden illnesses and deaths at the same time, were matters of general observation. All these circumstances, and the severe prevalence of the epidemic about the same time in the 34th, 53d, and 54th regiments, sufficiently show the existence of some general cause of disease, particularly as we hear that the cholera sprung up again in Bengal about the same period; but its effects necessarily must be greatly modified, increased, or prevented, by particular circumstances. The 54th must have contained many subjects highly susceptible of the disease, from being just arrived from a temperate climate, and having never before experienced it. They have therefore suffered the most, though, from being in quarters, they were more favourably situated than the others. The 53d was exposed to one of the principal exciting causes of the disease, residence in camp, and besides must have suffered a very great increase of temperature in passing from Mysore into the Carnatic, at the hottest time of the year. The 34th, in addition to the former of these causes, suffered much from excessive intemperance arising from the volunteering; but the epidemic had distinctly begun to appear before the drinking began.

One of the most striking, and best established facts, regarding the causes of the disease is, that troops are more subject to it in camp than in quarters; so much so, that I believe bodies of men have rarely moved in the country of late years, without suffering from it. It is well worthy of inquiry, and probably might be fully ascertained, whether standing and marching camps are equally obnoxious to it? In the late instance in the 34th regiment, it is evident that marching had no share in producing it, for they had moved only seven miles, and that a week before it appeared. It is very probable that the great increase of temperature suddenly experienced on moving from quarters into camp, and the relaxation and debility thereby produced, are the circumstances which render the latter situation so much more subject to cholera than the former. On the above-mentioned occasion, I found the heat of the tents extremely oppressive and enervating. During an inspection of the volunteers at that time, I observed the scrota of the men excessively relaxed and pendulous; whilst on a similar occasion, a few days after-

Wallajahbad, they were as generally found in their natural state of half contraction. It is probable that the heat of camp produced a correspondent want of tone throughout the whole system, as well as in that particular part.

No case of cholera appeared in the 34th regiment for several months before the 14th of May. From that day to the 25th, the day on which the corps marched for Wallajahbad, it prevailed severely, irregularly increasing and diminishing. On the 25th the cases were rather numerous, but all manageable, and after that, for about a week no case appeared. On the 1st and 2d of June several more cases occurred; after which they again disappeared until the 19th. On that and the next day three cases happened, one of which was a patient in the hospital, who was much reduced from an attack of continued fever, but convalescent. He neglected for six hours to apply for assistance, and rapidly sank and died. The total number of cases is eighty-seven, of whom twenty have died at head quarters, and one in general hospital at Madras.

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